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Summer Scotian Shelf and Bay of Fundy research vessel survey update for 2006

Mise à jour sur le relevé d'été de 2006 effectué par un navire de recherche sur le plateau néo-écossais et dans la baie de Fundy

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ABSTRACT

The 2006 Scotian Shelf summer Research Vessel (RV) survey was conduct between July 5th, and August 4th, 2006 onboard the CCGS Alfred Needler. The Needler made 116 fishing sets during the first leg of the survey, and 113 during the second leg. In NAFO Div. 4X5Y (strata 470-495), 81 valid tows were completed, while 129 valid tows were completed in NAFO Div. 4VW, strata 440-466) and 6 sets were completed in strata 496-498 (Scotian shelf edge; depth > 200 fm, Fig. 1). There were 101 species of fish captured, and 63 species of invertebrates. Hydrographic data were collected at all fishing stations.

Details on data collected, protocols followed, areas covered and species captured are provided. Trends in abundance, biomass, and area occupied are presented for selected commercial species, and for species for which the data display a pronounced trend.

RÉSUMÉ

Le relevé d'été de 2006 effectué par un navire de recherche (NR) sur le plateau néo-écossais a été mené entre le 5 juillet et le 4 août 2006 à bord du NGCC Alfred Needler. Le Needler a jeté 116 filets de pêche à l'eau pendant la première partie du relevé et 113 durant la deuxième. Dans la division 4X5Y de l'OPANO (strates 470 à 495), 81 traits valides ont été réalisées, alors que 129 l'ont été dans la division 4VW (strates 440 à 466) et six calées dans les strates 496 à 498 (bordure du plateau néo-écossais; profondeur >200 brasses, fig. 1). Cent une espèces de poissons et 63 espèces d'invertébrés ont été prises. En outre, des données hydrographiques ont été recueillies à toutes les stations de pêche.

Des détails sur les données recueillies, les protocoles suivis, les zones couvertes et les espèces prises sont fournis. De plus, des tendances relatives à l'abondance, à la biomasse et à la zone occupée sont présentées pour certaines espèces commerciales et les espèces pour lesquelles les données montrent une tendance prononcée.

Introduction

The DFO summer research vessel (RV) survey of the Scotian Shelf and Bay of Fundy has been conducted annually since 1970. The survey follows a stratified random sampling design, and includes both hydrographic sampling and sampling of fish and invetebrates using a bottom otter trawl. These survey data are the primary data source for monitoring trends in species distribution, abundance, and biological condition, and also for monitoring hydrographic variability within the region. This document is intended to provide a synopsis of the findings of the 2006 survey and examine these data in the context of long-term survey results.

Plots of the size and distribution of catches are provided for selected species and stratified average catches are compared with past results to provide a general overview of trends in abundance, biomass and area occupied. The survey area has been divided into three zones, based on oceanography and biogeography. Trends are shown for the entire survey area, and also for three separate regions: Eastern Scotian Shelf (4VW; strata 440-469), Western Scotian Shelf (4X east; strata 470-481), and Gulf of Maine/Bay of Fundy (4X west; strata 482-495. Differences in patterns of fish abundance and species composition are apparent for these regions during the survey.

Data are presented for the major commercial species, for species which comprise a large part of the survey catch, and for species where the 2006 catch was either unusually high or low. The set of species examined to determine if catches in 2006 were unusual was restricted to those where the area occupied exceeded 5000 square nautical miles (approximately $1/10^{th}$ of the surveyed area) in 2006, or averaged greater than this in the 1970's, the 1980's or the 1990's. The species examined were restricted in this manner to avoid rare species for which catches display high inter-annual variability.

Sampling of Trawl Catch

Basic data, total numbers and weight caught, and length frequencies were collected from all successful sets according to instructions in the Groundfish Bottom Trawl Surveys Manual (Draft 2.4).

Length stratified samples for individual fish weight, one per centimeter (by sex if required), were taken from each set for all species. In addition, otoliths were taken from cod, haddock, pollock, white hake, silver hake, cusk and herring. Maturity stages were assigned for silver hake, cusk and herring. All sampling and set information were entered directly to a database with online data editing using an Oracle-based data entry system (GSE).

Hydrographic Observations

At all successfully fished stations, profiles of temperature, conductivity (salinity), oxygen concentration, fluorescence and irradiance (PAR extinction) were obtained with a SBE-25 CTD fitted on a Carousel Rosette deployed by the C.C.G.S *Alfred Needler*. Niskin bottles attached to the Rosette collected water from the bottom, 25m (intermediate depth) when possible, and from 5m (near surface) for the following sampling:

- 5m: salinity (x1), nutrients (x2), chlorophyll-a (x2) and oxygen determination (x2)
- 25m: nutrients (x2), chlorophyll-a (x2)
- Bottom: salinity (x1), nutrients (x2), chlorophyll-a (x2) and oxygen determination (x2)

Oxygen measurements were performed after the CTD cast using an ORION 842 bench meter. Salinity determinations were made using a Guildline salinometer. Chlorophyll-a samples were processed onboard with a Turner-Designs fluorometer.

Surface temperatures were measured using a VEMCO SEATEMP temperature probe, and VEMCO depth/temperature MINILOGGERs were attached to the trawl to monitor bottom water temperature.

Additional sampling was undertaken for the Atlantic Zonal Monitoring Program (AZMP). At 35 selected stations, vertical zooplankton tows (76 and 202 micron mesh) were made from bottom to surface. The Halifax hydro station was occupied 3 times during the course of the mission. On each occasion the following sampling was done:

- Vertical CTD profile of the entire water column (including a fluorometer and dissolved oxygen probe)
- Two vertical zooplankton net tows from bottom to surface (with flow meter); one with each of the 76 and 202 micron nets
- Secchi depth measurement
- Niskin bottle samples at 10 depths through the water column.samples analyzed for oxygen, nutrients, salinity, chlorophyll-a, and phytoplankton.

Trawl Mensuration: Scanmar sensors were used to document the trawl characteristics. Wing spread, door spread, headline height, and clearance were all recorded for sets when possible.

Results

The annual DFO research vessel survey of the Scotian Shelf and Bay of Fundy was conducted on the CCGS Alfred Needler between July 5th and August 4th, 2006. The Needler made 116 fishing sets during the first leg of the survey, and 113 during the second leg. Overall, 11 tows were designated as unrepresentative (type

3) either due to net damage, or because tow duration was less than 20 minutes and 2 sets were made in an attempt to capture live fish. In NAFO Div. 4X5Y (strata 470-495), 81 valid tows were completed, while 129 valid tows were completed in NAFO Div. 4VW, strata 440-466) and 6 sets were completed in strata 496-498 (Scotian shelf edge; depth > 200 fm, Fig. 1).

The trawl was lost with all scanmar gear while towing near Emerald Bank during the first leg of the survey. Repeated attempts to retrieve it were unsuccessful, and we abandoned the effort after about 6 hours. At the end of the second leg of the survey, the vessel returned to the location of the lost net and again attempted to retreive it, this time successfully. All of the lost gear was recovered.

One Scanmar wing sensor and stainless steel canister were lost on a tow in 4X. The pins in both shackles attaching the canister to the trawl sheared off. The shackles remained on the gear, clearly indicating what had occurred. Heavier shackles with a higher breaking strength will be obtained prior to the next survey.

With the loss of much of the Scanmar gear during the first leg of the survey, little information was collected during the second leg. Only headline height sensors were available for much of the second leg. While door spread sensors could be used, door spread data were difficult to obtain with scanmar during the survey. Scanmar was generally successfully in logging door spreads while the net was in mid-water, but the readings were frequently lost when the doors hit bottom, and tranmission was often poor during the tow. This suggests that the doors may be leaning inwards, and the brackets holding the sensors may not be correctly angled to ensure the sensors are pointing at one another. This problem was also encountered in the early 1990's. At that time, adjustable brackets were installed, and the angle adjusted through trial and error. This work may need to be re-done if door spread data are to be collected regularly.

There were 101 species of fish recorded during the survey (Table 2). The most frequently captured fish were haddock, American plaice, silver hake, redfish and cod, while those contributing most to the weight caught were haddock, redfish, pollock and dogfish.

There were 63 separate invertebrates codes used during the survey (Table 3). The most frequently captured were starfish, short-fin squid, snow crab and *Pandulus montagui*, while *Pandulus borealis*, short-fin squid, and sea cucumbers contributed most to the weight of the invertebrate catch.

Identification of all corals was verified in the lab at BIO immediately following completion of the survey. Those which were lisited as unidentified at-sea have had the correct species designation added to the database. A large collection of invertebrates, along with a smaller number of unidentified fish were delivered to the ARC for identification. No identifications are available for these specimens yet. Most of these specimens were photographed during the survey, and if

identifications are available prior to the next survey, these photographs will be annotated and provided as guides to identification at-sea.

Non-standard sampling

A variety of samples were collected in addition to those required as part of our standard sampling protocols (Table 1). Collection of herring otoliths, and identification of stomach contents have been proposed as standard collections for future surveys. These were attempted this year to determine the feasibility of including these protocols on the Needler, given the restrictions on numbers of personnel that can be accommodated onboard. With the inclusion of this sampling the work in the fish lab was often too time consuming to complete. While there are times that sampling can be completed quickly, overall, completing the full set of survey stations was difficult in the time allotted. Some review of sampling requirements will be required to reduce the time required in the lab, or additional sea time will be needed if all the sampling attempted this summer is to be completed at sea.

Notes on distribution and abundance of sampled species

Distribution and biomass trend plots are included for some of the major fish and invertebrates in the survey catch (Tables 2 and 3) and for other species of commercial importance. This includes haddock, redfish, squid and snow crab, as well as cod, silver hake, shrimp and scallops. Data are also examined for species which were noted during the 2006 surveys as more common than in recent years, such as turbot, squid and black-belly rose fish, or as unusually scarce, such as argentine. In addition, an exploration of survey time series data was undertaken to determine which species had experienced major changes in area occupied or abundance over the time period. Species for which recent large changes in area occupied were found were argentine, lobster, winter skate and turbot.

Turbot appeared to be more abundant and wide-spread than usual (Fig. 2). While still found primarily on the eastern Scotian Shelf, the area occupied has been increasing consistently (Fig. 2c).

Blackbelly Rosefish also seemed to be quite abundant (Fig. 3). Some large catches of rosefish were made, resulting in a continued increase in the biomass estimate; however, the area occupied remained at the same level as in recent years (Fig. 3).

Squid were also more abundant than usual (Fig. 4); they were wide-spread, and several large catches were made, resulting in one of the highest biomass estimates in the survey series.

Halibut were caught in several areas during the survey (Fig.5). Catches were sparse in western 4X, and biomass remains low in that area. Biomass estimates

increased, however, for both eastern 4X and 4VW. The total survey biomassestimate remains amongst the highest in the series, and the area occupied for halibut is the highest since 1980.

Large catches of Pollock (Fig. 6), Redfish (Fig. 7) and hagfish (Fig. 8) were noted in the Bay of Fundy Gulf of Maine area (western 4X), and large catches of lobster were made along the edge of Browns Bank (Fig. 9). These large catches led to high estimates of biomass for each of these species. Lobster have shown an increasing trend in both biomass and area occupied over the last decade.

Other species were notable for their scarcity. Two large catches of cod were made in 4W (Fig. 10); otherwise, cod abundance was very low, particularly in 4X. For both eastern and western 4X, the catch of cod was the lowest in the series.

Argentine were caught in few sets during the survey and are at their lowest level for both biomass and area occupied during the series (Fig 11). The significance of this decline is not immediately obvious, as argentine, like herring, are primarily pelagic and abundance may not be directly reflected in bottom trawl catches. It is possible that changes in survey catch may reflect behavioural changes which are evinced as shifts in vertical distribution. In addition, the range inhabited by argentine extends off the edge of the shelf, and the deeper parts of this range are not covered by the survey. A more thourough investigation of the distribution and abundance of argentine are required to determine if the trends displayed in the survey are an accurate reflection of population trends.

Dogfish, which in recent years have often made the largest contribution to the total catch, while still caught in most tows in the Gulf of Maine and Bay of Fundy, were less abundant than in most recent years (Fig. 12).

Silver hake catches were low again in 2006 (Fig. 13). While they remained wide-spread, no large catches were made, and overall biomass remains low.

Herring catches dropped again in 2006 in 4X (Fig. 14) with no large catches of herring taken in 4X. Some large catches of herring in 4VW resulted in an overall increase for the survey from 2005. The interpretation of trends in abundance for herring in this survey are not clear. While the survey catch remains an order of magnitude higher in all areas compared to the 1980's and early 1990's, the assessment indicates this does not reflect trends in abundance.

Both red hake (Fig. 15) and white hake (Fig. 16) catches declined in 2006, with most of the decline in western 4X. The biomass estimate for red hake is the lowest in the series (starting in 1982), while for white hake it is among the lowest in the series.

The following figures show trends in weight over the survey time series from 1970-2006 for several groundfish species.

Winter skate biomass declined in 2006 (Fig. 17). Area occupied remains stable in western 4X, but has continued to decline in eastern 4X and 4VW, where it is at the lowest levels for the time series.

Wolfish (Fig. 18), monkfish (Fig. 19), ocean pout (Fig. 20) and thorny skate (Fig. 21) all remain near the lowest biomass levels for the time series.

Time series are too short to provide much context for many of the major invertebrates in the catch. For *Pandalus montagui* (Fig. 22), *P. borealis* (Fig. 23), and snow crab (Fig. 24), the biomass estimates are with in the range observed in other years (1999 – present). *P. montagui* was caught throughout much of the survey area, while *P. borealis* and snow crab were caught primarily in 4VW.

Unlike the rest of the large commercial gadids, overall haddock biomass remains fairly high (Fig 25). Haddock are caught throughout the survey range. There were no large catches of haddock in western 4X, and biomass is low for that area, but biomass is about average in eastern 4X and 4VW.

Bottom temperature and salinity

Temperature and salinity data were collected at each station (Fig. 26). Contour plots of these data show general patterns of water masses in the region. The general patterns are consistent with past years: the Easterm Scotian Shelf had cold water, the central shelf had warm saline water, and the inner Bay of Fundy had warm water of low salinity. An area of quite warm and saline water was detected intruding on the south-east end of Browns Bank.

Conclusions

The objectives of the 206 survey were successfully completed, and the survey data are available on Divisional data bases for investigation. Some increases to sampling objectives were successfully integrated in 2006. A process for insuring coral are identified to species was formally established. Other additions to sampling protocols were less successful. Identification of stomach contents at sea proved difficult. Similarly, removal and storage of herring otoliths was problematic. These procedures will need to be reviewed before the 2007 survey.

Table 1. Additional sampling undertaken during the 2006 summer RV survey.

Pollock	156 Gill tissue for genetics analysis
Dogfish	235 Condition sampling: total length, fork length, total weight, gutted weight Age and maturity: dorsal spines collected and maturity recorded as per manual. Fecundity: Measure and sex embryos, measure yolk sac and measure 5 largest ova.
Winter Skate	116 fin clips for genetic analysis
Skate Purses:	57 Weighed and counted and entered in GSE
Stomach Content ID:	approx 1149 fullness index done at sea and 461 frozen for later analysis
Cod	4VsW/4Vn – 200 cod for parasite sampling from each area
Plaice	4Vn – 200 plaice for parasite sampling
Herring	467 otoliths collected, 613 total lengths and fork length recorded to nearest mm.
Bar Code of Life:	200 specimens collected

Table 2. Summary of fish catch from the 2006 summer RV survey

Species Code	Common Name	Number of sets occupied	Total Number	Total weight (kg)	Age Samples
11	HADDOCK	151	22511	8643.464	2012
40	AMERICAN PLAICE	142	5176	1083.204	
14	SILVER HAKE	119	9840	711.557	1272
23	REDFISH UNSEPARATED	111	45764	7315.977	
10	COD(ATLANTIC)	106	4843	2602.018	597
41	WITCH FLOUNDER	103	1324	258.303	
60	HERRING(ATLANTIC)	86	11934	2267.705	467
300	LONGHORN SCULPIN	86	1612	267.95	
12	WHITE HAKE	80	739	436.008	443
42	YELLOWTAIL FLOUNDER	78	4852	768.904	
201	THORNY SKATE	69	480	305.389	
320	SEA RAVEN	57	326	171.56	
43	WINTER FLOUNDER	49	1255	332.265	
16	POLLOCK	45	1467	3923.073	262
220	SPINY DOGFISH	44	1672	2847.197	235
30	HALIBUT(ATLANTIC)	43	72	324.125	
13	SQUIRREL OR RED HAKE	42	181	28.994	
340	ALLIGATORFISH	39	240	0.557	
31	TURBOT,GREENLAND HALIBUT	36	598	339.859	
610	NORTHERN SAND LANCE	34	22308	424.863	
202	SMOOTH SKATE	31	126	46.272	
400	MONKFISH,GOOSEFISH,ANGLER	31	62	78.08	
50	STRIPED ATLANTIC WOLFFISH	30	84	98.007	
241	NORTHERN HAGFISH	30	171	7.995	
640	OCEAN POUT(COMMON)	30	86	18.407	
62	ALEWIFE	27	255	30.646	
880	HOOKEAR SCULPIN,ATL.	27	206	0.872	
304	MAILED SCULPIN	26	261	2.151	
204	WINTER SKATE	22	343	131.63	
64	CAPELIN	21	221	3.732	
112	LONGFIN HAKE	21	480	47.43	
114	FOURBEARD ROCKLING	21	64	3.055	
410	MARLIN-SPIKE GRENADIER	21	124	4.073	
647	SHORTTAILED EELPOUT(VAHL)	20	167	14.205	
623	DAUBED SHANNY	18	287	1.824	
61	SHAD AMERICAN	17	44	26.885	
123	ROSEFISH(BLACK BELLY)	17	697	109.89	
203	LITTLE SKATE	17	86	56.604	
350	ATLANTIC SEA POACHER	14	52	0.924	
501	LUMPFISH	14	19	32.26	
160	ARGENTINE(ATLANTIC)	13	38	10.55	
712	WHITE BARRACUDINA	13	85	1.25	
150	LANTERNFISH (NS)	12	558	1.096	
622	SNAKE BLENNY	11	53	1.46	
15	CUSK	10	22	41.76	21
502	ATLANTIC SPINY LUMPSUCKER	9	10	0.114	
159	BOA DRAGONFISH	8	225	5.785	
19	OFF-SHORE HAKE	7	12	14.24	
44	GULF STREAM FLOUNDER	7	16	0.305	
602	GRAY'S CUTTHROAT EEL	7	65	1.815	
604	SNIPE EEL	6	32	0.405	
143	BRILL/WINDOWPANE	5	11	2.656	
221	BLACK DOGFISH	5	47	7.735	
619	EELPOUT,NEWFOUNDLAND	5	5	2.73	
625	RADIATED SHANNY	5	23	0.218	
630	WRYMOUTH	5	9	2.79	
701	BUTTERFISH	5	6	0.225	
17	TOMCOD(ATLANTIC)	4	227	6.635	
63	RAINBOW SMELT	4	8	0.14	
155	LONGTOOTH ANGLEMOUTH	4	11	0.25	
156	SHORT-NOSE GREENEYE	4	8	0.089	
646	ATLANTIC SOFT POUT	4	16	0.107	
169	VIPERFISH	3	7	0.143	
505	SEASNAIL,GELATINOUS	3	5	0.014	
512	SEASNAIL,DUSKY	3	3	0.434	
621	ROCK GUNNEL(EEL)	3	3	0.036	
70	MACKEREL(ATLANTIC)	2	203	40.61	
142	FOURSPOT FLOUNDER	2	2	1.875	
149	LONGNOSE GREENEYE	2	2	0.019	
200	BARNDOOR SKATE	2	4	26.75	
301	SHORTHORN SCULPIN	2	5	0.99	
411	ROUGHHEAD GRENADIER	2	4	2.214	

Table 3. Summary of inverttebrate catch from the 2006 summer RV survey

Species Code	Common Name	Number of sets occupied	Total Number	Total weight (kg)
6100	ASTEROIDEA S.C.	181	1645	117.881
4511	SHORT-FIN SQUID	165	14453	1841.348
2526	SNOW CRAB (QUEEN)	76	1412	167.741
2212	PANDALUS MONTAGUI	68	75315	272.674
6600	SEA CUCUMBERS	63	280	1907.712
2550	AMERICAN LOBSTER	52	477	602.41
2511	JONAH CRAB	52	201	31.755
4321	SEA SCALLOP	45	347	41.505
6400	SEA URCHINS	43	371	36.04
4521	OCTOPUS	40	64	1.661
4200	SNAILS AND SLUGS	40	118	9.791
8300	SEA ANEMONE	39	119	56.878
2521	HYAS COARCTATUS	39	286	17.711
2559	HERMIT CRABS	38	87	2.703
1224	SKATE UNID. EGGS	36	57	8.854
2211	PANDALUS BOREALIS	34	182058	1517.791
2416	CRANGON SP.	32	1110	4.4376
2513	ATLANTIC ROCK CRAB	31	267	22.18
6411	STRONGYLOCENTROTUS DROEBACHIENSIS	27	244	58.585
6511	ECHINARACHNIUS PARMA	26	95	8.434
2523	NORTHERN STONE CRAB	25	42	10.849
4300	BIVALVIA C.	13	23	1.297
4210	WHELKS	13	25	1.373
6500	SAND DOLLARS	12	56	3.29
8318	SEA PEN	11	82	0.428
4322	ICELAND SCALLOP	11	62	5.56
8324	SEA CAULIFLOWER, STRAWBERRIES	9	1	1.588
3200	SEA MOUSE	9	18	0.956
2527	TOAD CRAB	9	17	0.76
3212	APHRODITA SP.	7	22	2.064
8600	SPONGES	6	26	8.395
2532	RED DEEPSEA CRAB	6	17	2.95
2100	SHRIMPS	6	8667	14.95
2990	BARNACLES	5	39	2.455
8327	SEA CAULIFLOWER = DUVA SPP	4	0	0.416
2213	WAS PANDALUS PROPINQUUS	4	2011	2.456
2200	PANDALIDAE F.	4	301	0.695
8335	CUP CORAL	3	8	0.289
4536	SEPIOLIDAE F.	3	4	0.042
3100	BRISTLE WORMS	3	16	0.37
1827	SEA PEACH	3	5	0.265
4522	SEMIROSSIA TENERA	2	0	0.02
4514	SQUID (NS)	2	3	0.025
4330	MUSSELS (NS)	2	7	0.31
2600	KRILL SHRIMP	2	147	0.045
2519	SPIDER CRAB (NS)	2	2	0.002
2000	CRUSTACEA C.	2	1	0.169
8530		1	0	0.01
8500	JELLYFISHES	1	0	0.795
8332	CORAL (NS)	1	0	54.31
6000	SPINY SKINNED ANIMALS	1	16	0.125
4500	CEPHALOPODA C.	1	0	0.005
4343	GREENLAND COCKLE	1	0	0.003
4310	CLAMS (NS)	1	0	0.04
4304	OCEAN QUAHAUG	1	1	0.265
4221	NORTHERN MOONSNAIL	1	2	0.35
2556	MUNIDA VALIDA	1	0	0.015
2520	TOAD CRAB,UNIDENT.	1	1	0.16
2312	LEBBEUS POLARIS	1	1	0.005
2210	PANDALUS SP.	1	2	0.005

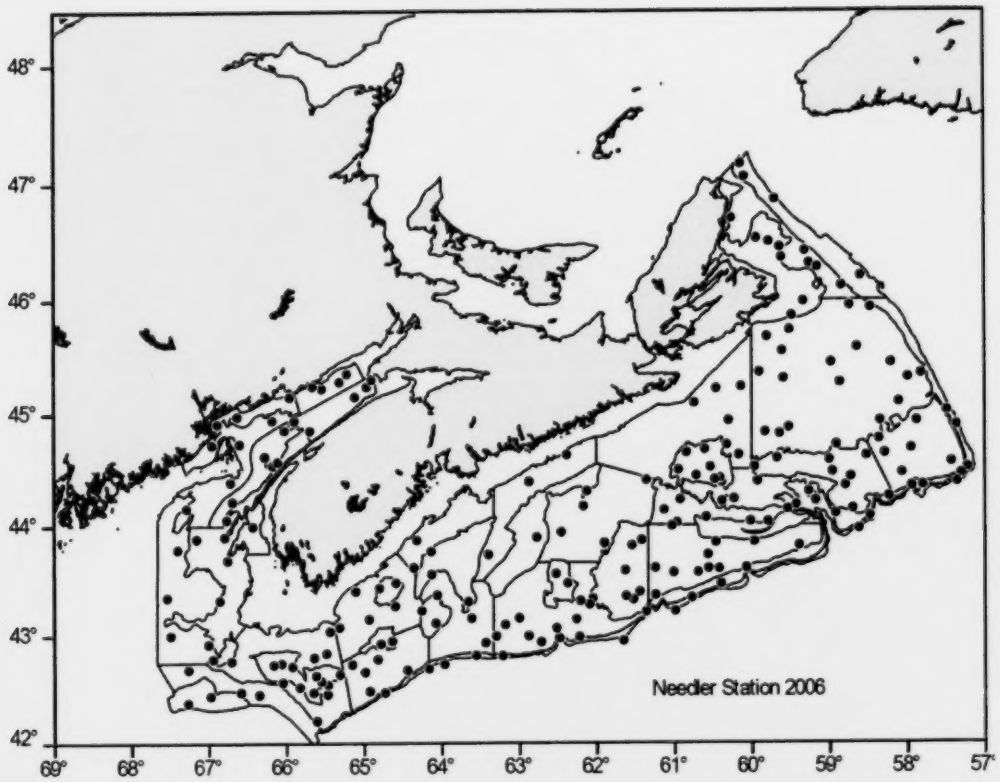

Figure 1. Station locations from the 2006 Scotia-Fundy Summer Ecosystem Survey

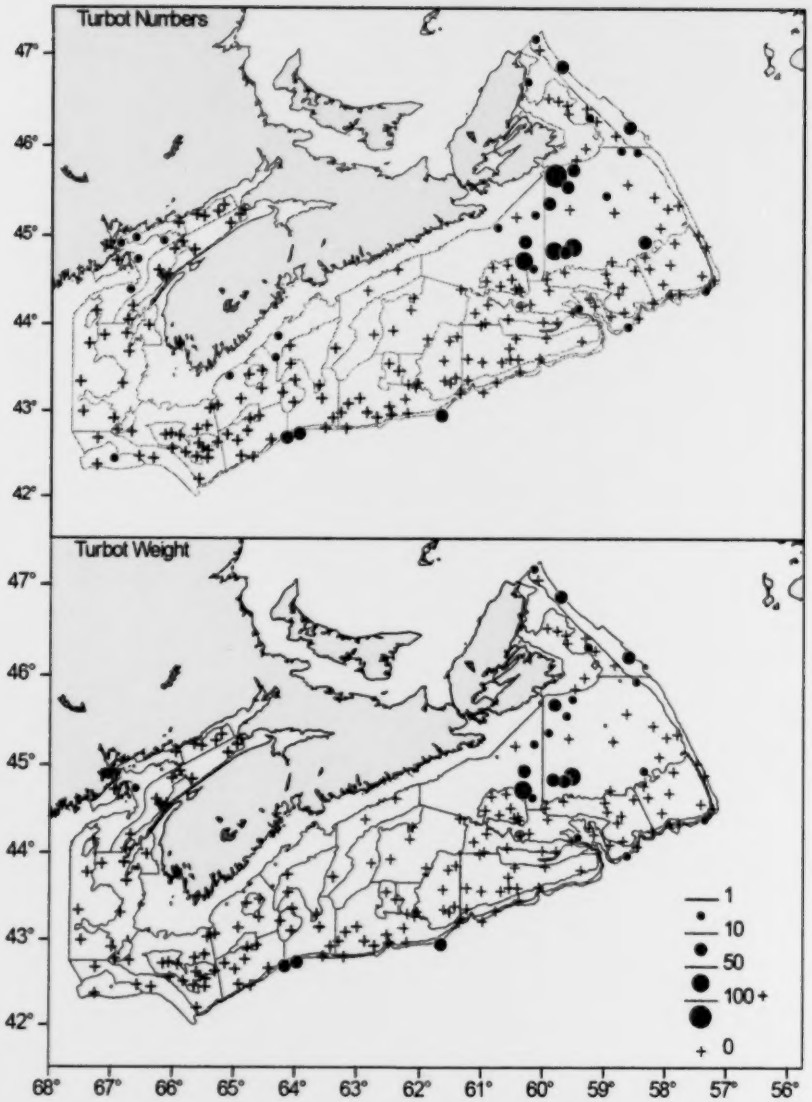

Figure 2a. Distribution of turbot catches during the 2006 Scotia-Fundy summer RV survey

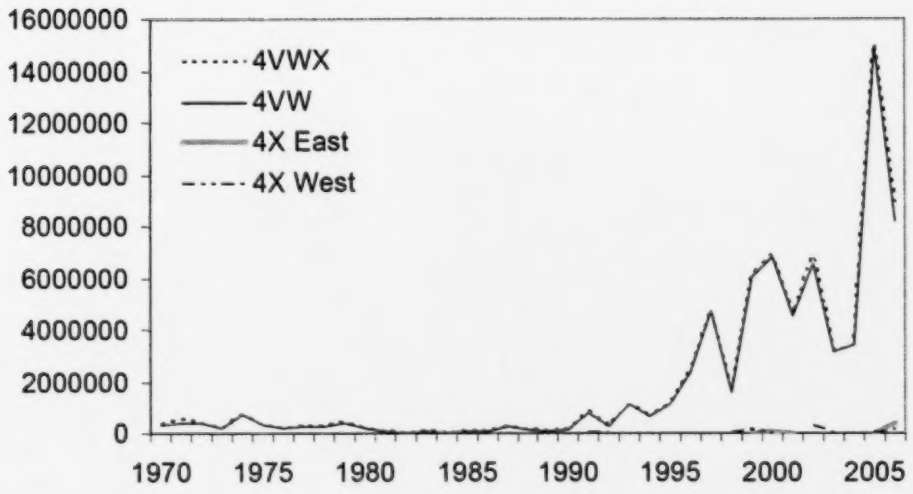

Figure 2b. Biomass estimate for turbot from the 2006 Scotia-Fundy summer RV survey.

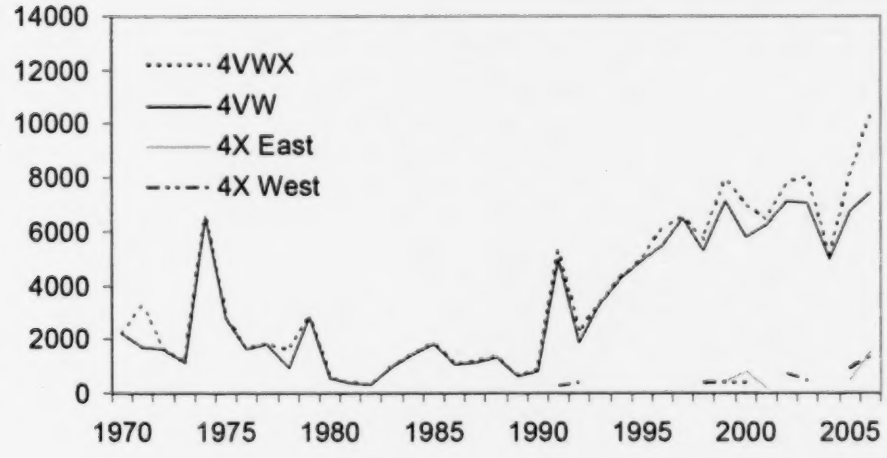

Figure 2 c. Stratified area occupied by turbot from the 2006 Scotia-Fundy summer RV survey.

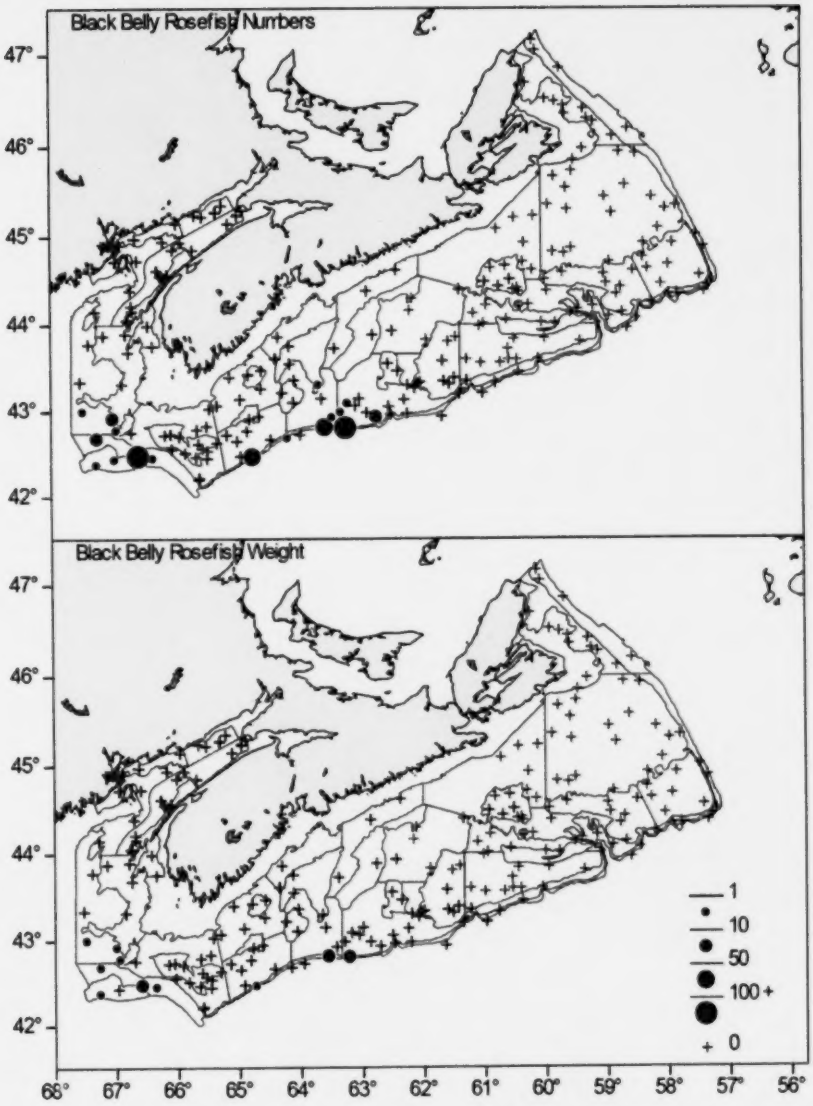

Figure 3a. Distribution of black-belly rosefish catches during the 2006 Scotia-Fundy summer RV survey.

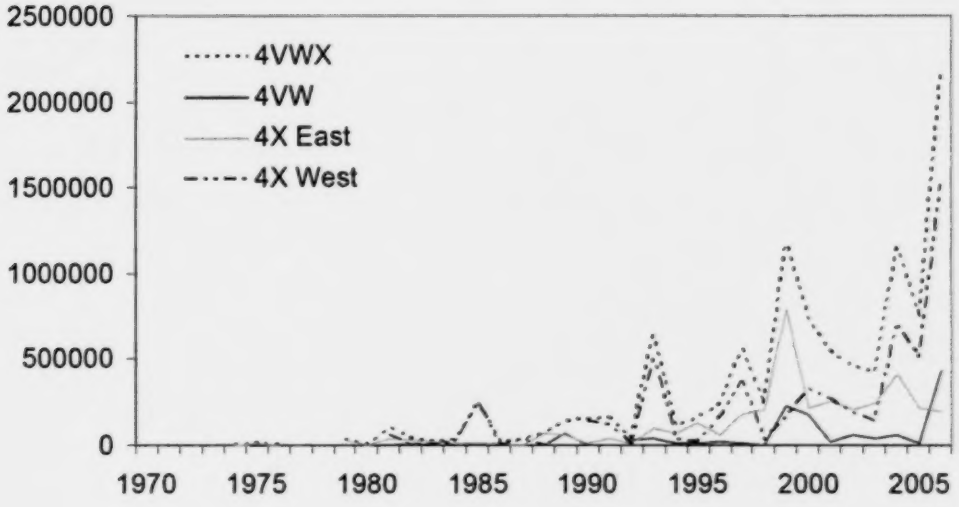

Figure 3b. Biomass estimate for black-belly rosefish from the 2006 Scotia-Fundy summer RV survey

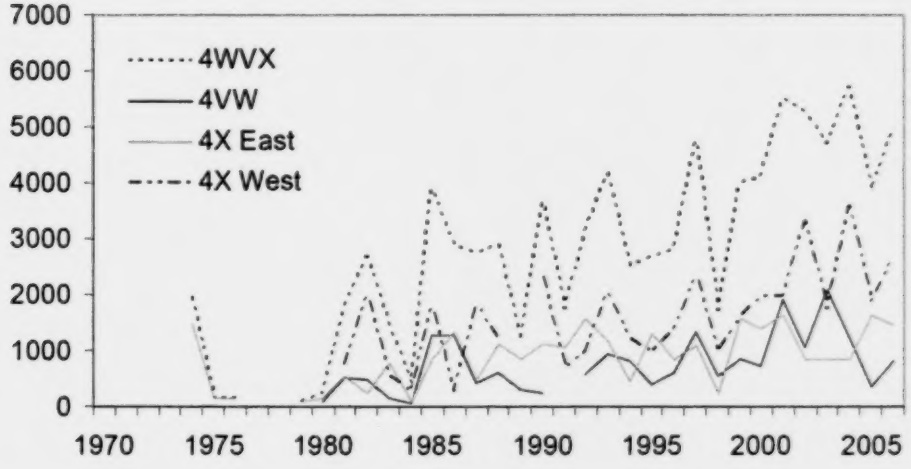

Figure 3c. Stratified area occupied by black-belly rosefish from the 2006 Scotia-Fundy summer RV survey.

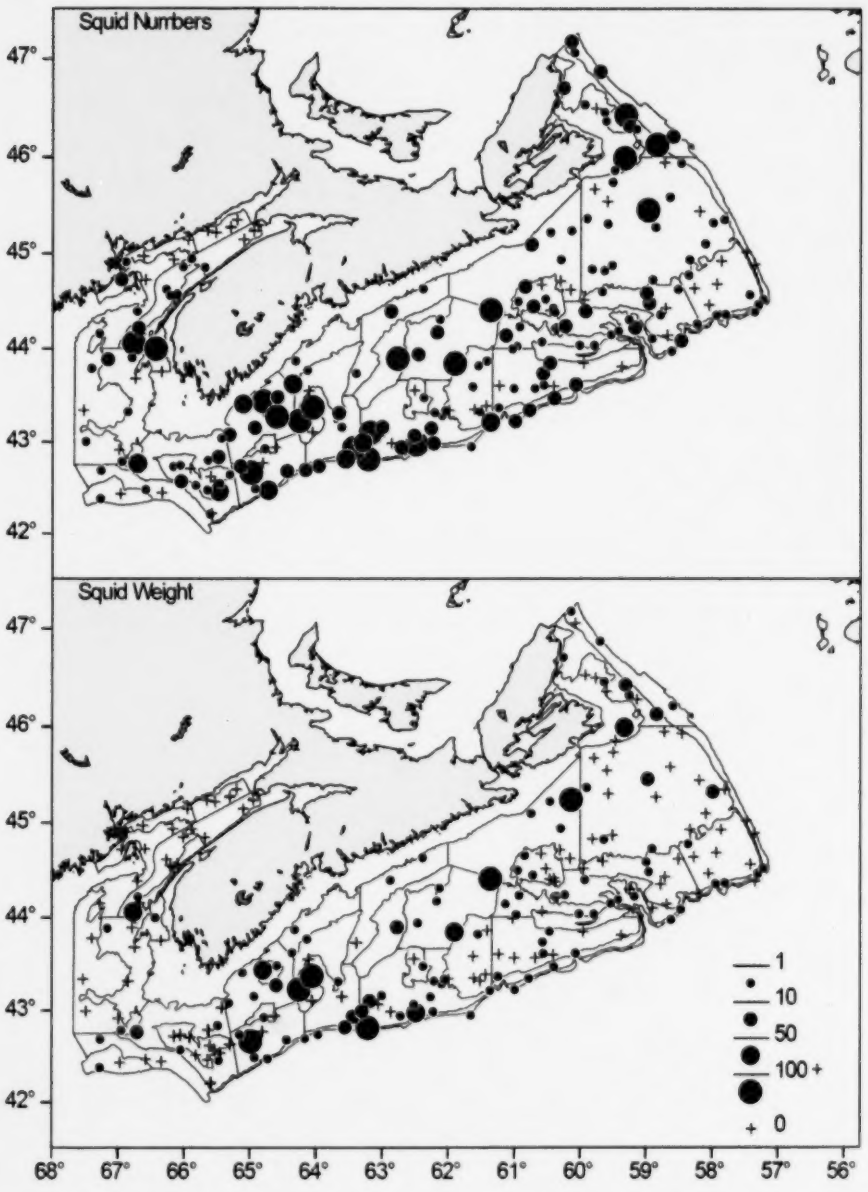

Figure 4a. Distribution of squid catches during the 2006 Scotia-Fundy summer RV survey.

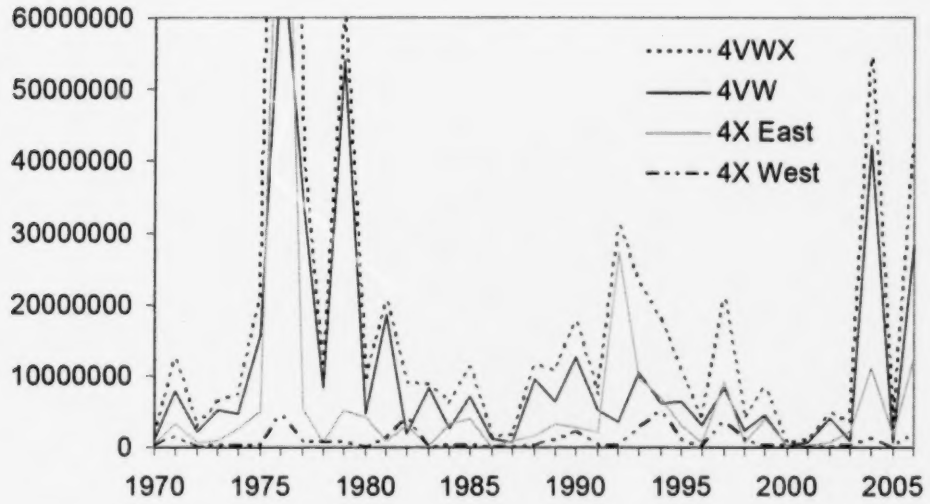

Figure 4b. Biomass estimate for squid from the 2006 Scotia-Fundy summer RV survey.

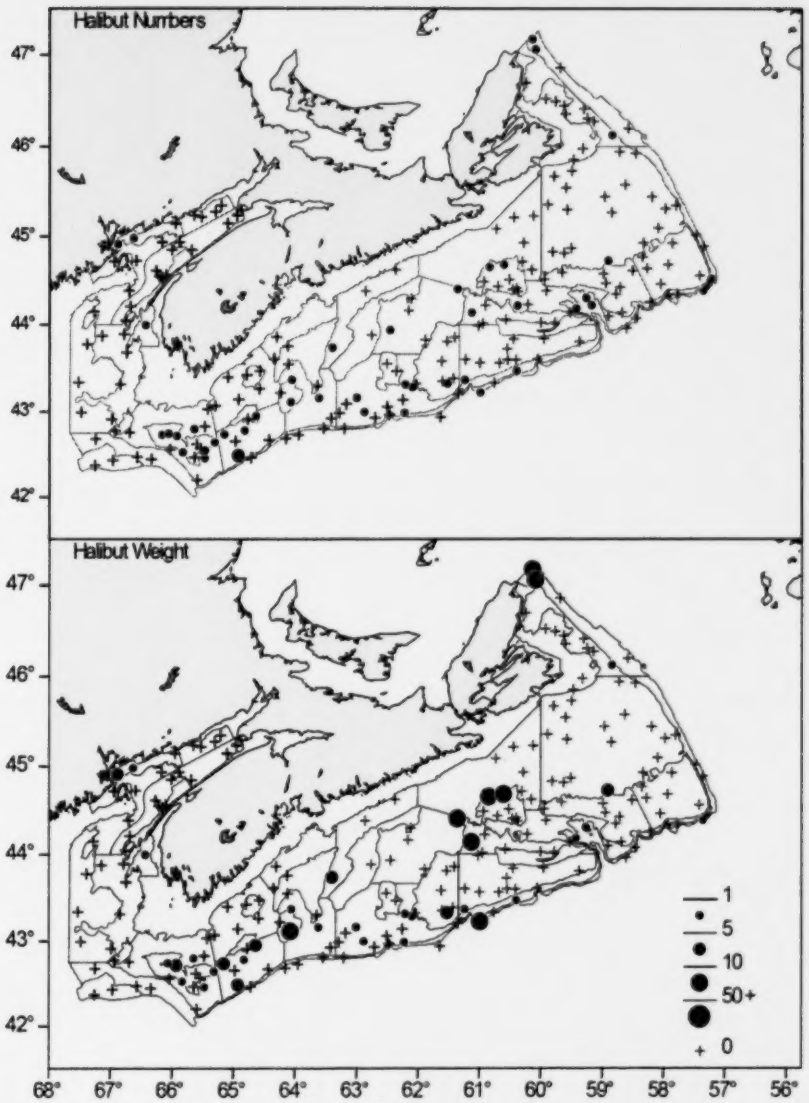

Figure 5a. Distribution of halibut catches during the 2006 Scotia-Fundy summer RV survey.

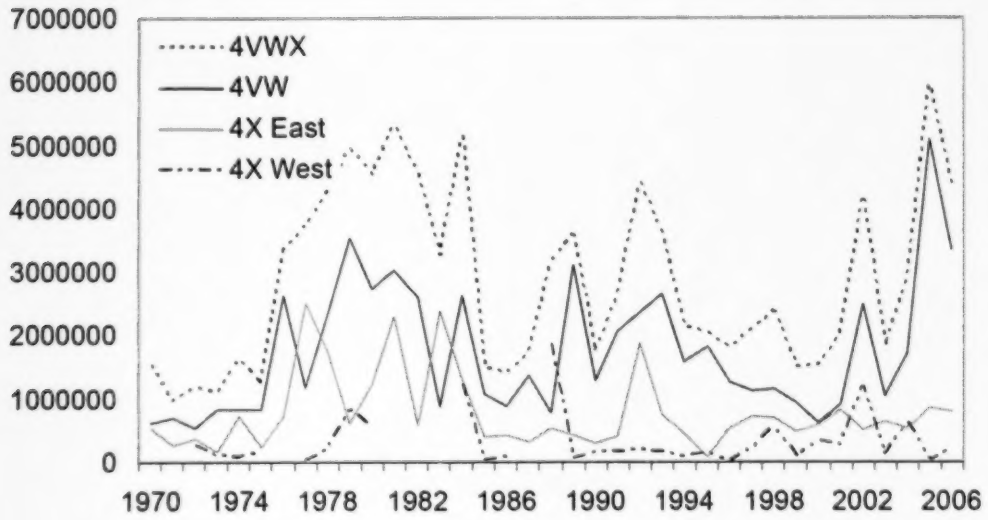

Figure 5b. Biomass estimate for halibut from the 2006 Scotia-Fundy summer RV survey.

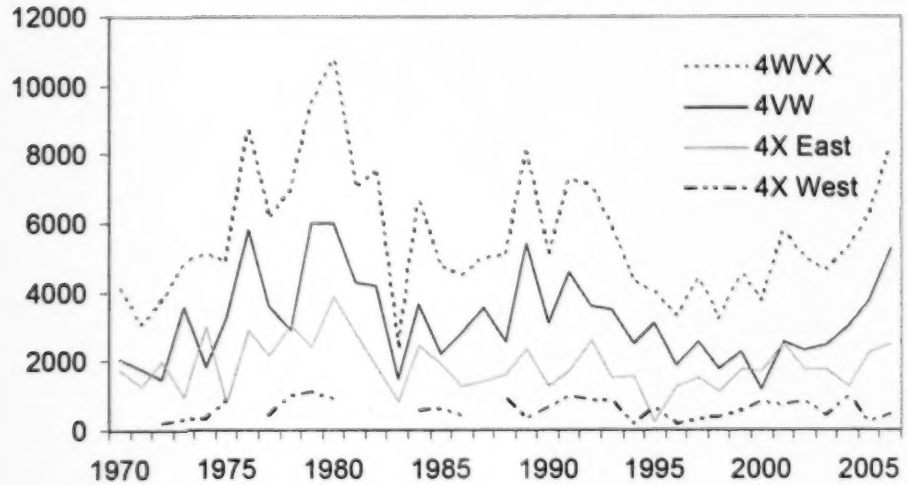

Figure 5c. Stratified area occupied by halibut from the 2006 Scotia-Fundy summer RV survey.

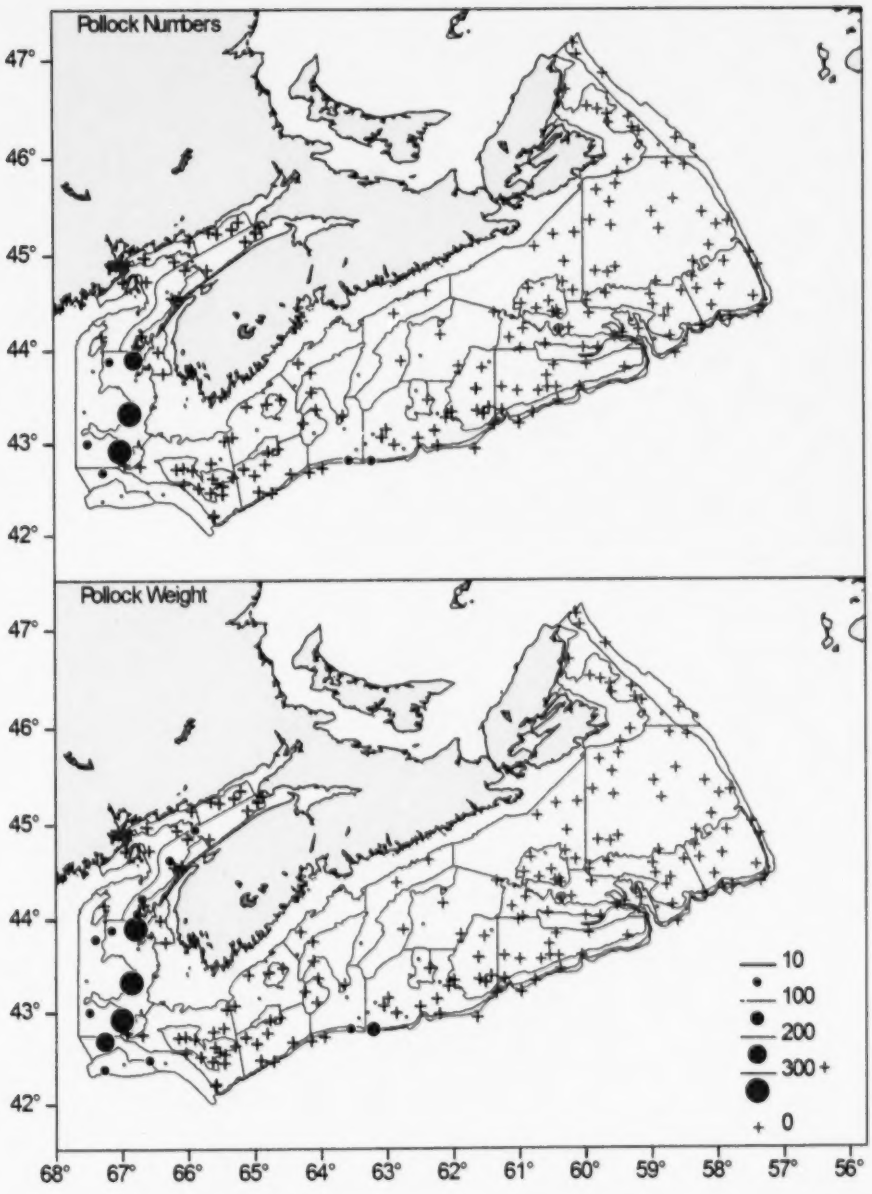

Figure 6a. Distribution of pollock catches during the 2006 Scotia-Fundy summer RV survey.

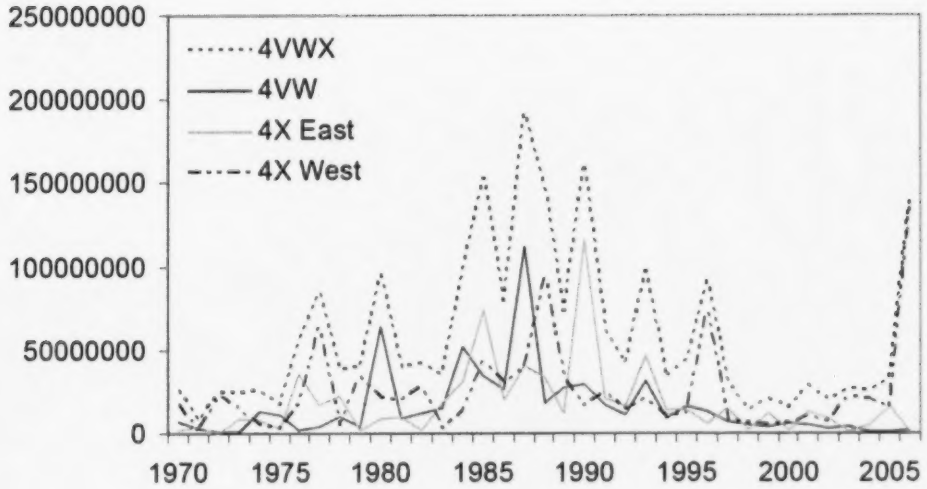

Figure 6b. Biomass estimate for pollock from the 2006 Scotia-Fundy summer RV survey.

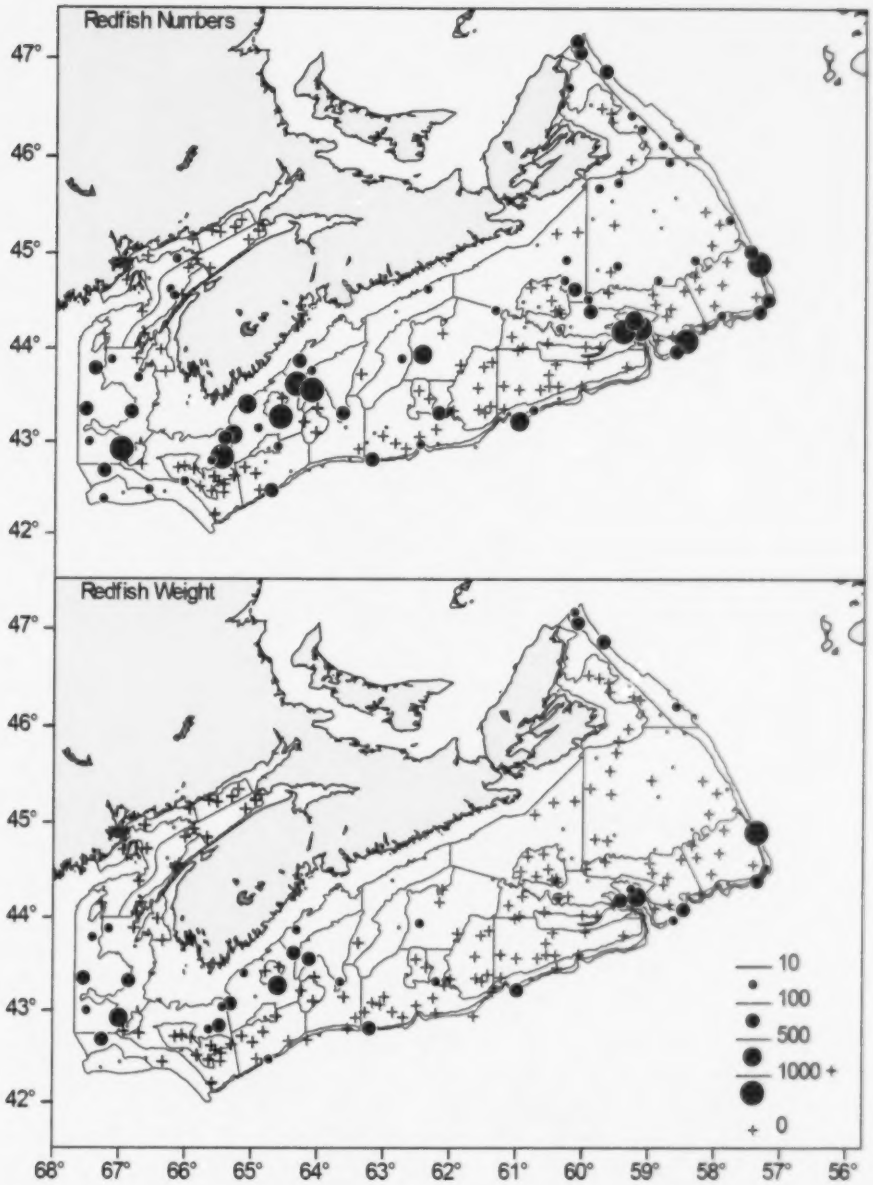

Figure 7a. Distribution of redfish catches during the 2006 Scotia-Fundy summer RV survey.

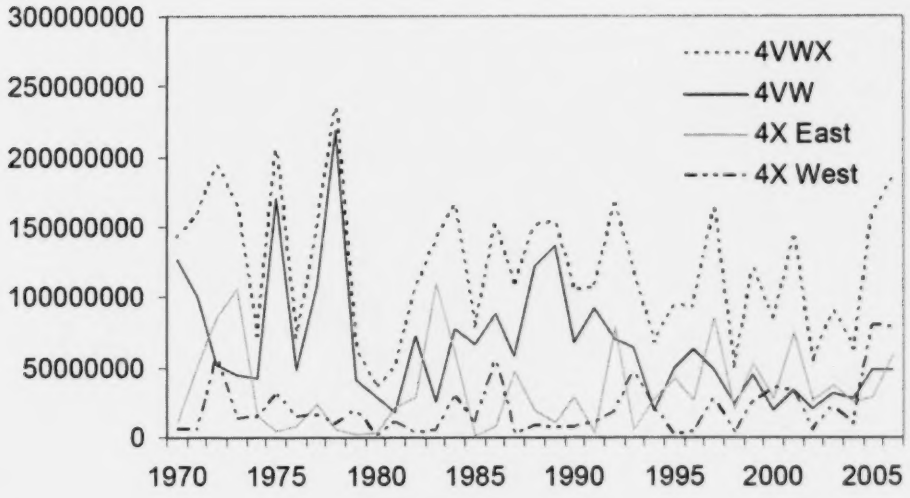

Fig. 7b Biomass estimate for redfish from the 2006 Scotia-Fundy summer RV survey.

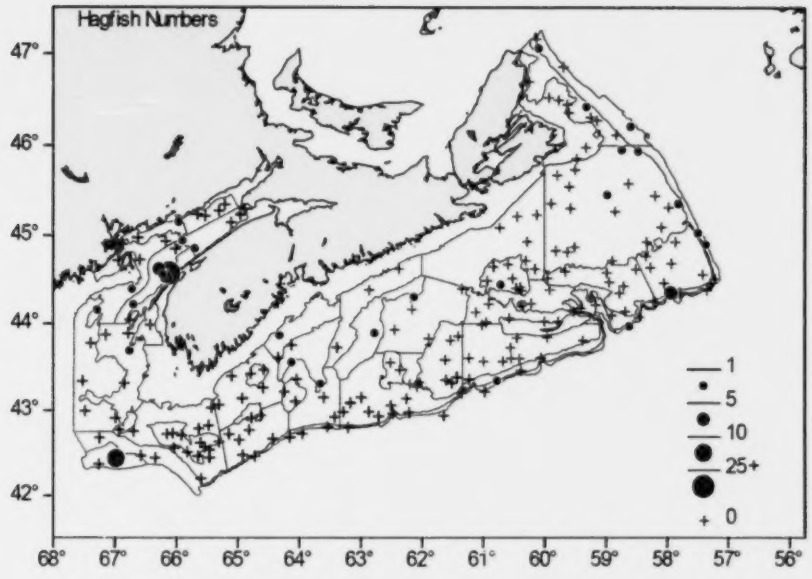

Figure 8a. Distribution of hagfish catches during the 2006 Scotia-Fundy summer RV survey.

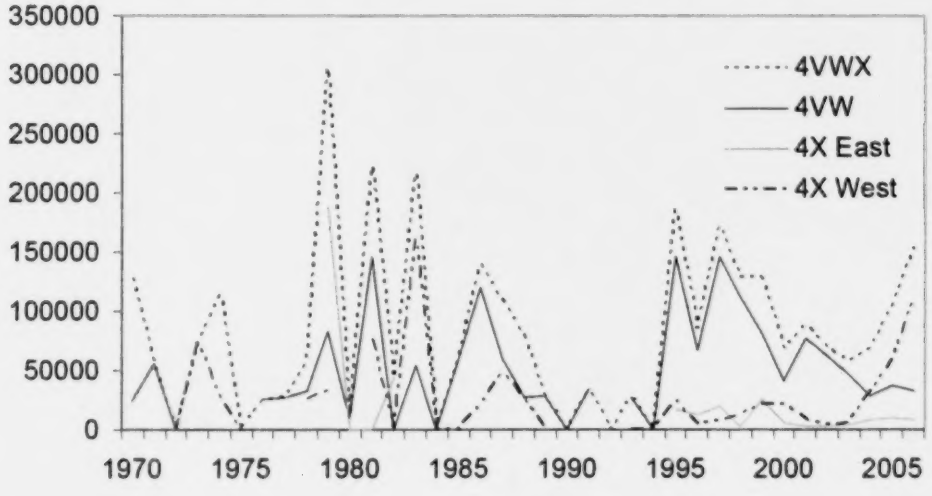

Figure 8b. Biomass estimates for hagfish from the 2006 Scotia-Fundy summer RV survey.

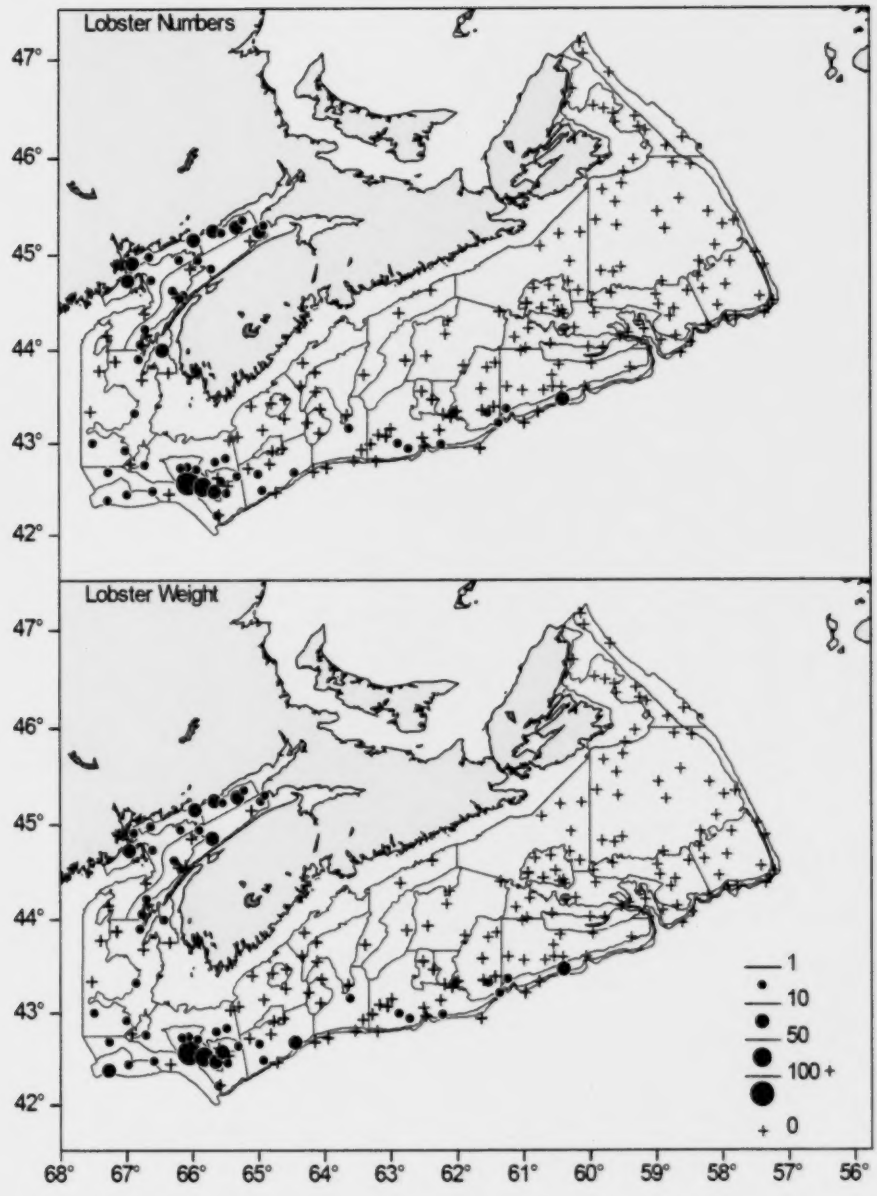

Figure 9a. Distribution of lobster catches during the 2006 Scotia-Fundy summer RV survey.

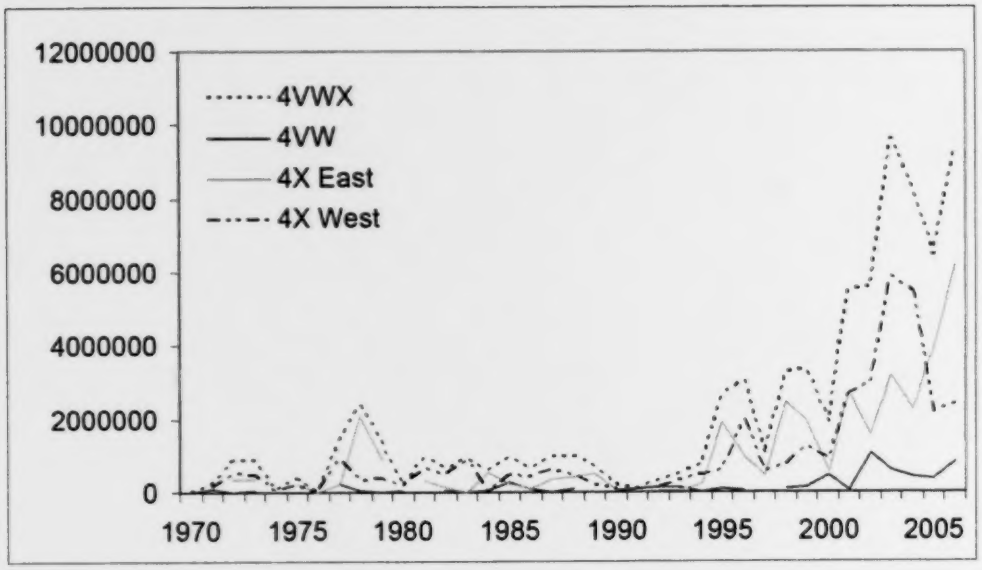

Fig. 9b. Biomass estimate for lobster from the 2006 Scotia-Fundy summer RV survey.

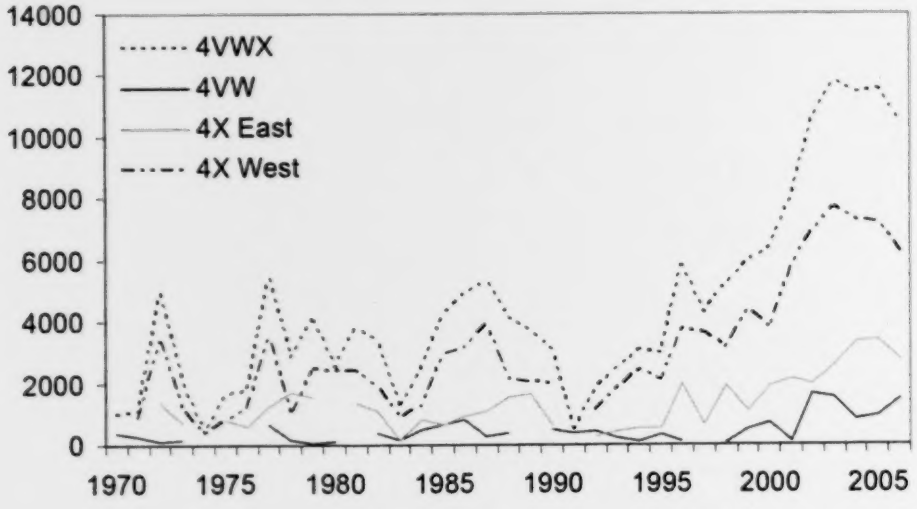

Figure 9c. Stratified area occupied by lobster from the 2006 Scotia-Fundy summer RV survey.

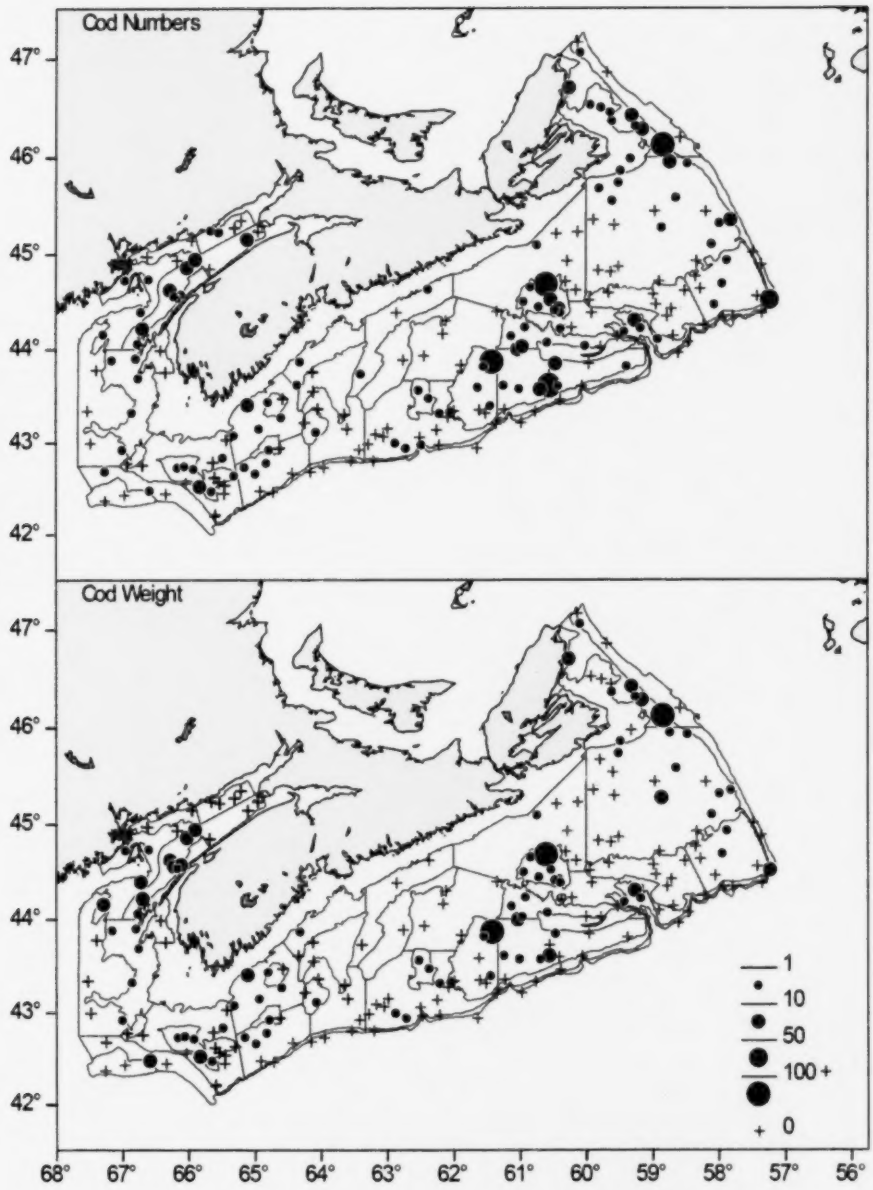

Figure 10a. Distribution of cod catches during the 2006 Scotia-Fundy summer RV survey.

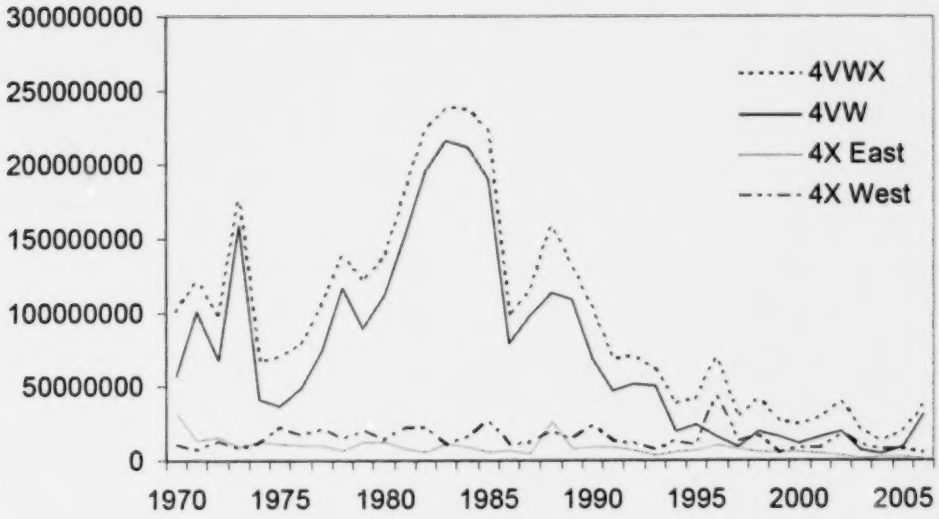

Fig. 10b. Biomass estimate for cod from the 2006 Scotia-Fundy summer RV survey.

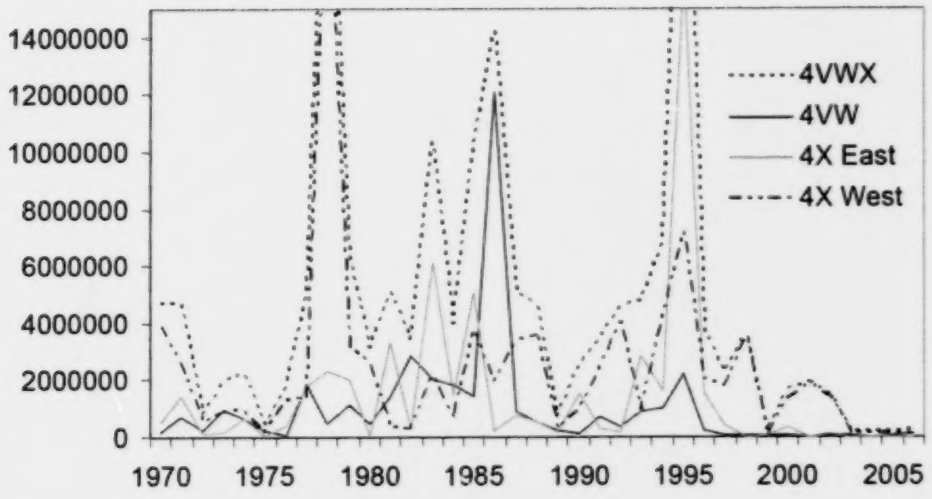

Figure 11a. Biomass estimates for argentine from the Scotia-Fundy summer RV survey.

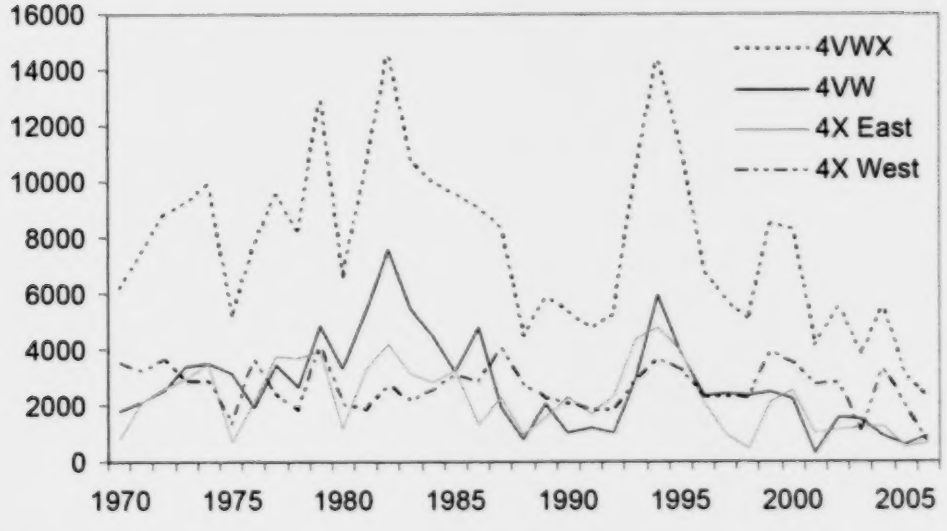

Figure 11b. Stratified area occupied by argentine from the Scotia-Fundy summer RV survey.

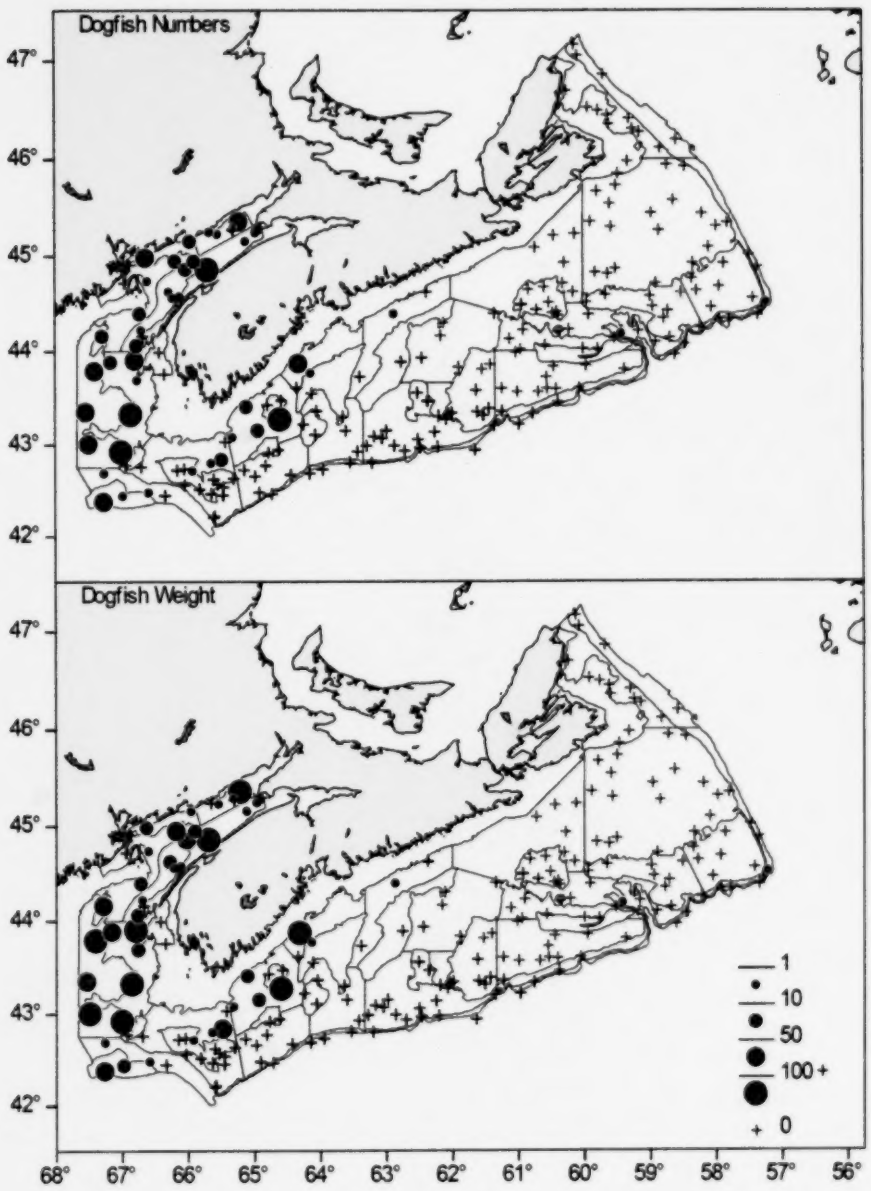

Figure 12a. Distribution of Dogfish catches during the 2006 Scotia-Fundy summer RV survey.

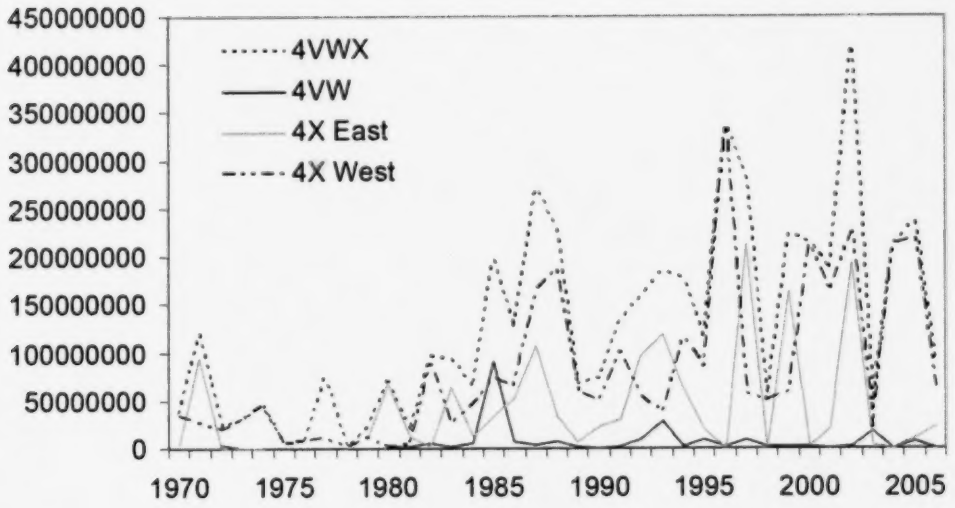

Figure 12b. Biomass estimates for dogfish from the 2006 Scotia-Fundy summer RV survey.

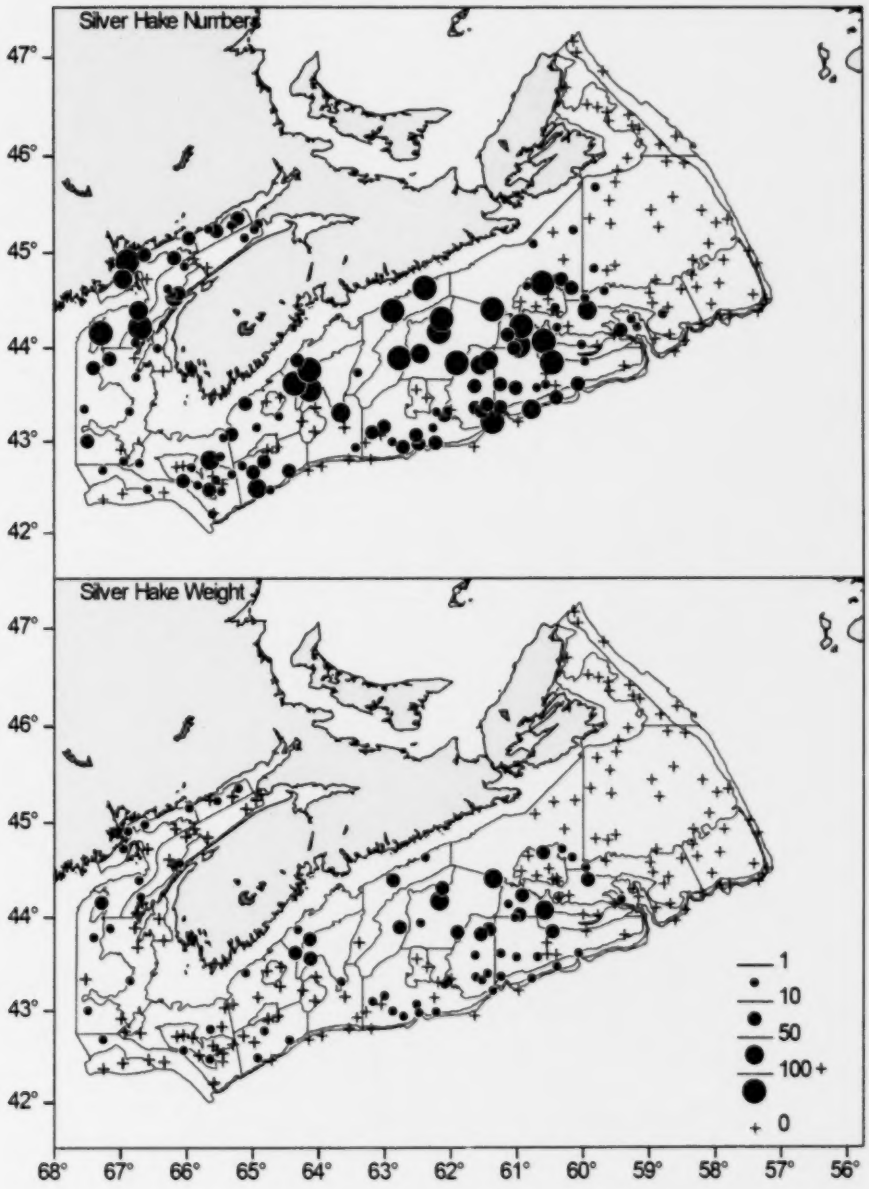

Figure 13a. Distribution of silver hake catches during the 2006 Scotia-Fundy summer RV survey.

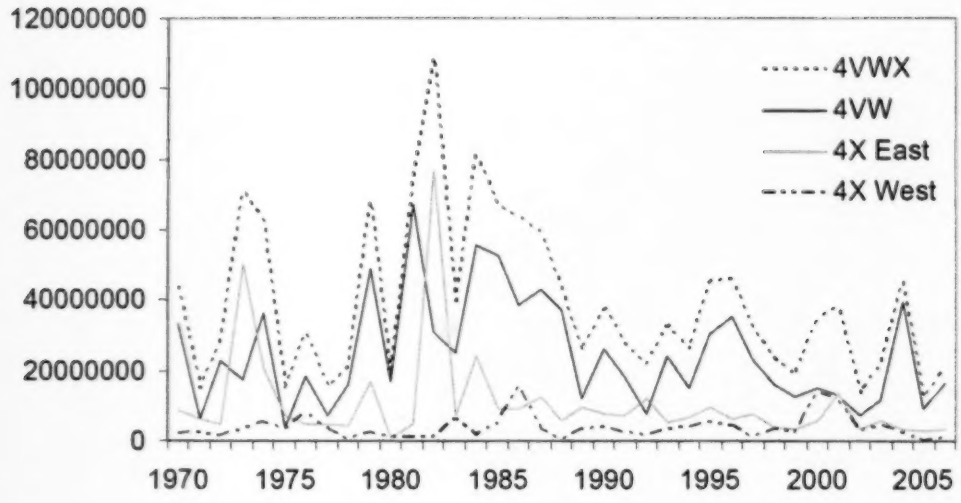

Figure 13b. Biomass estimates for silver hake from the 2006 Scotia-Fundy summer RV survey.

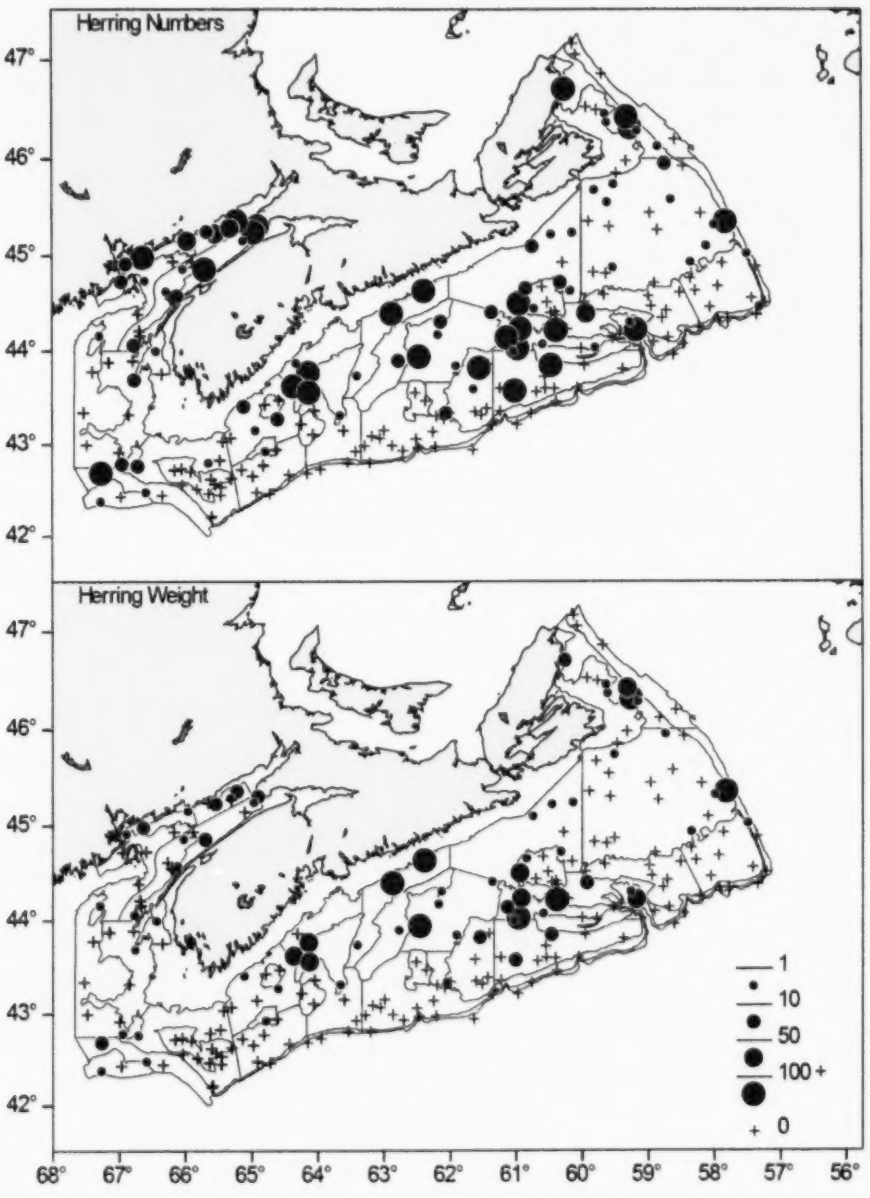

Figure 14a. Distribution of herring catches during the 2006 Scotia-Fundy summer RV survey.

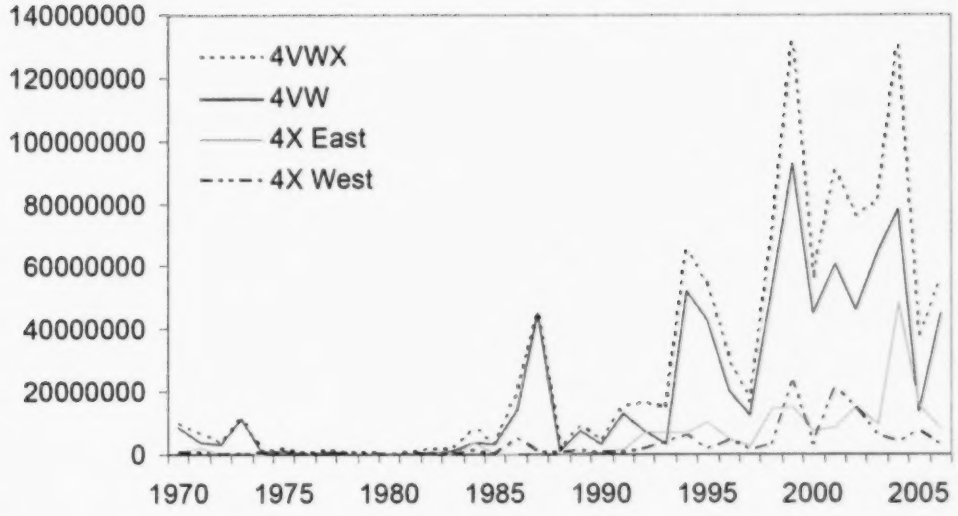

Figure 14b. Biomass estimates for herring from the 2006 Scotia-Fundy summer RV survey.

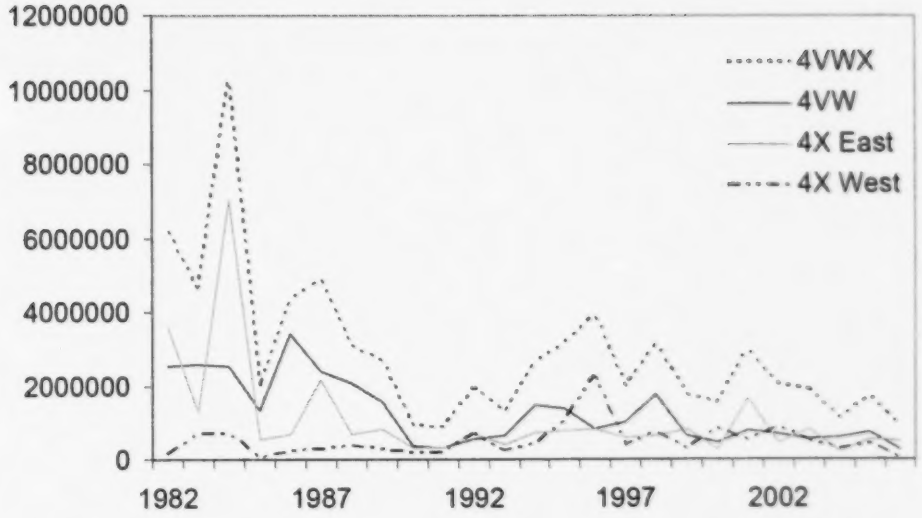

Figure 15. Biomass estimates for red hake from the 2006 Scotia-Fundy summer RV survey.

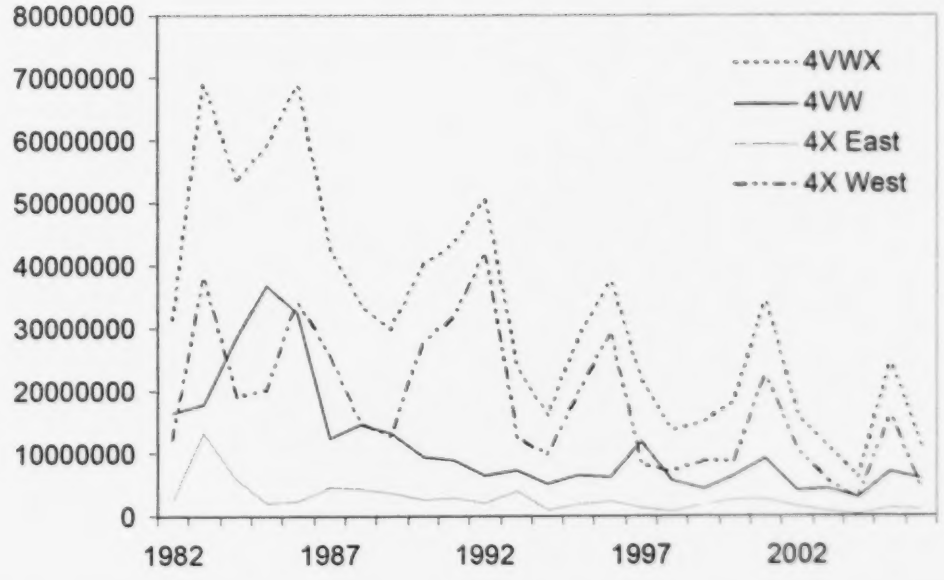

Figure 16. Biomass estimates for white hake from the 2006 Scotia-Fundy summer RV survey.

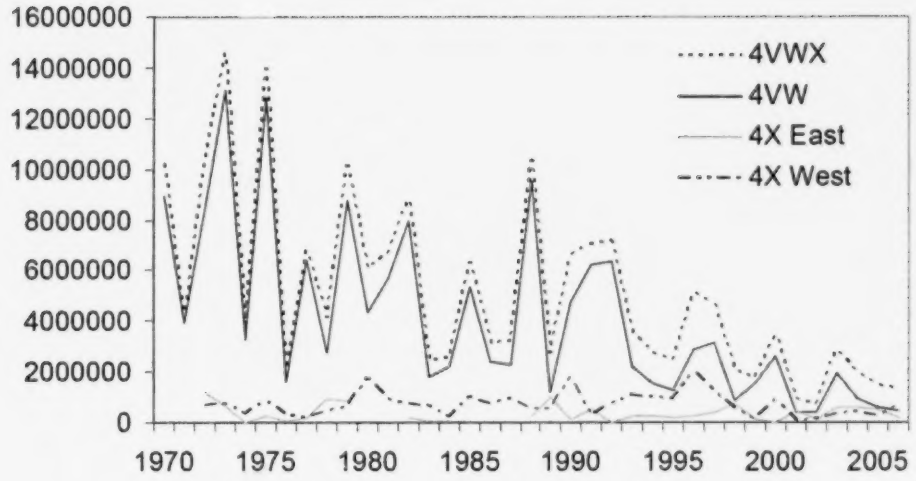

Figure 17a. . Biomass estimates for winter skate from the 2006 Scotia-Fundy summer RV survey.

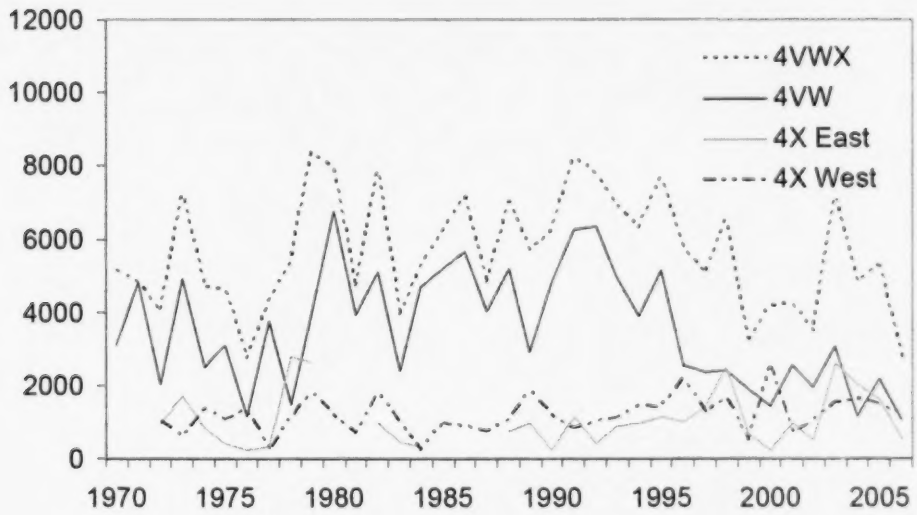

Figure 17b. Stratified area occupied by winter skate from the 2006 Scotia-Fundy summer RV survey.

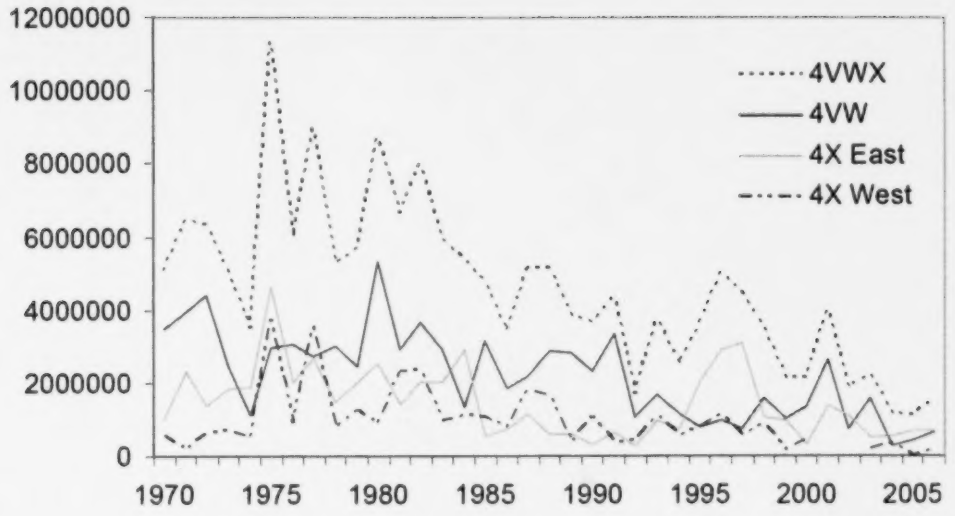

Figure 18. Biomass estimates for wolffish from the 2006 Scotia-Fundy summer RV survey.

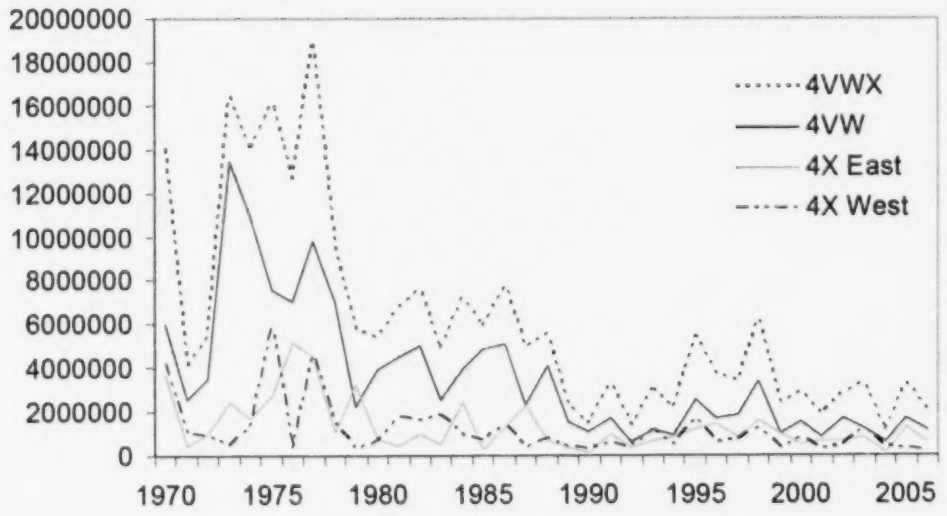

Figure 19. Biomass estimates for monkfish from the 2006 Scotia-Fundy summer RV survey.

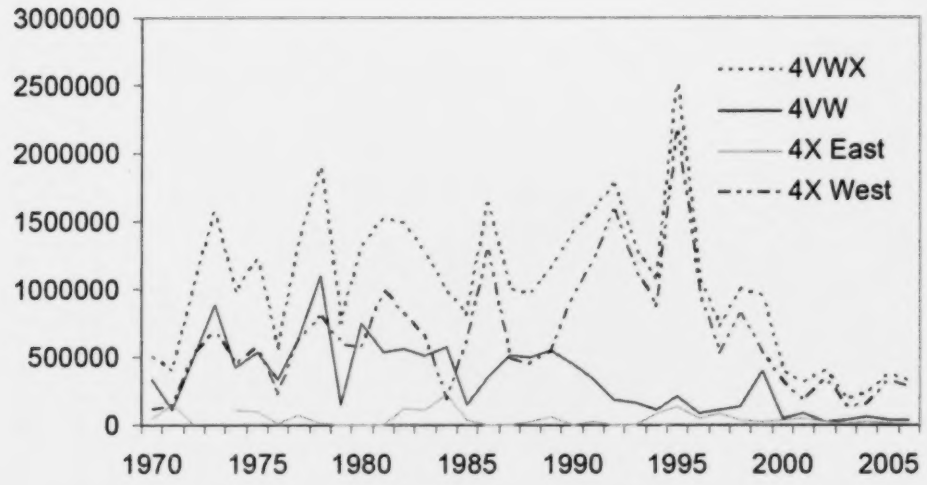

Figure 20. Biomass estimates for ocean pout from the 2006 Scotia-Fundy summer RV survey.

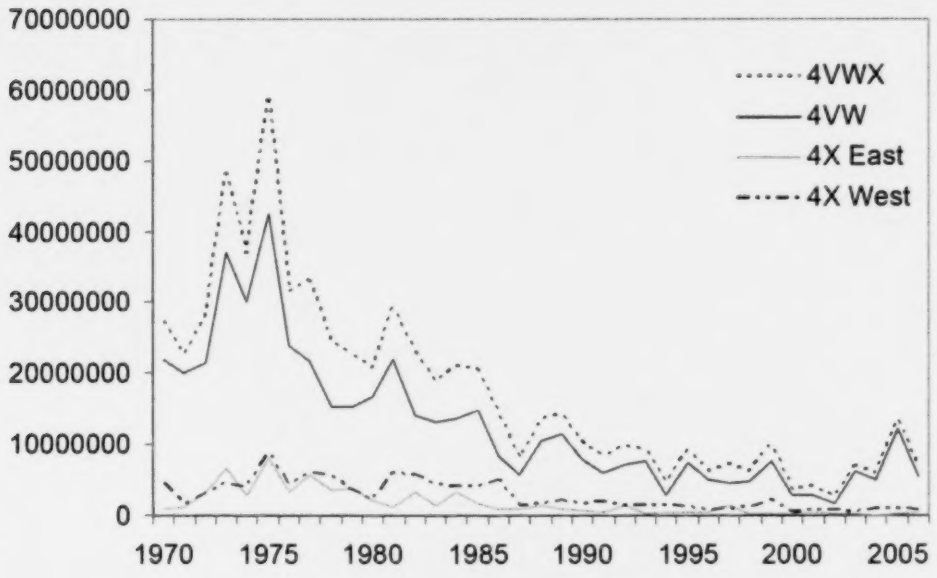

Figure 21. Biomass estimates for thorny skate from the 2006 Scotia-Fundy summer RV survey.

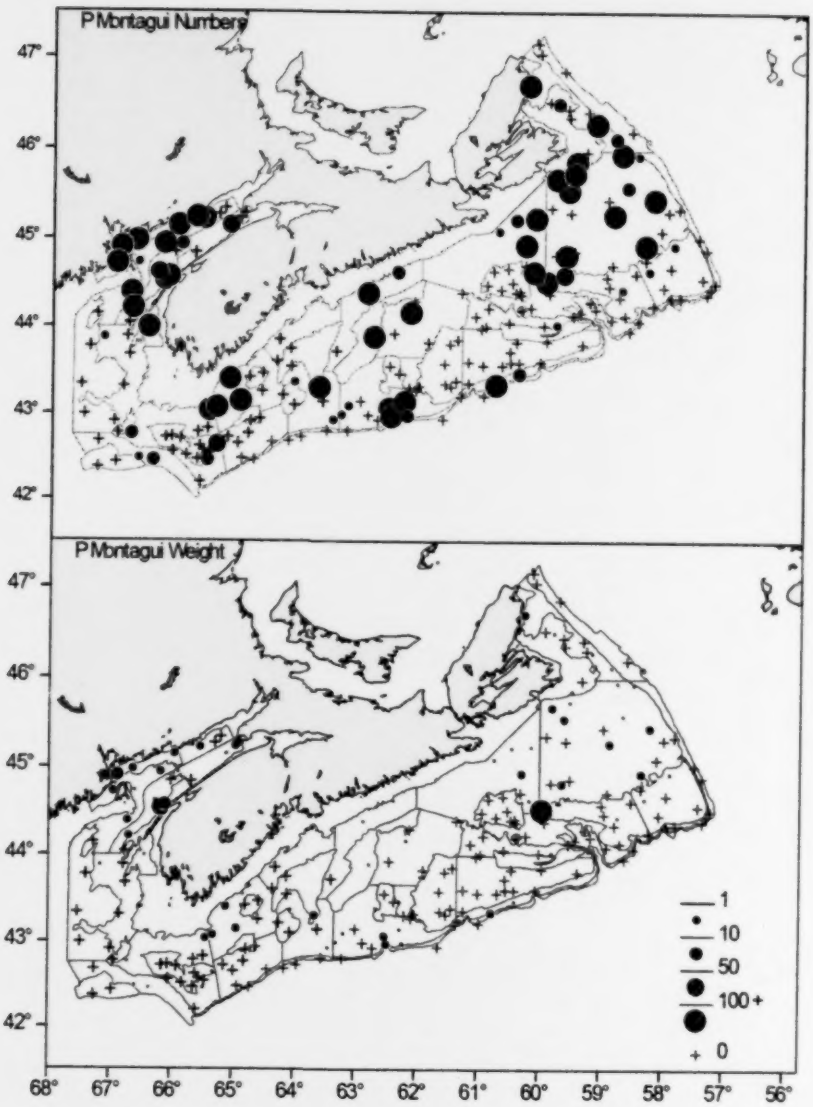

Figure 22. Distribution of *Pandalus montagui* catches during the 2006 Scotia-Fundy summer RV survey.

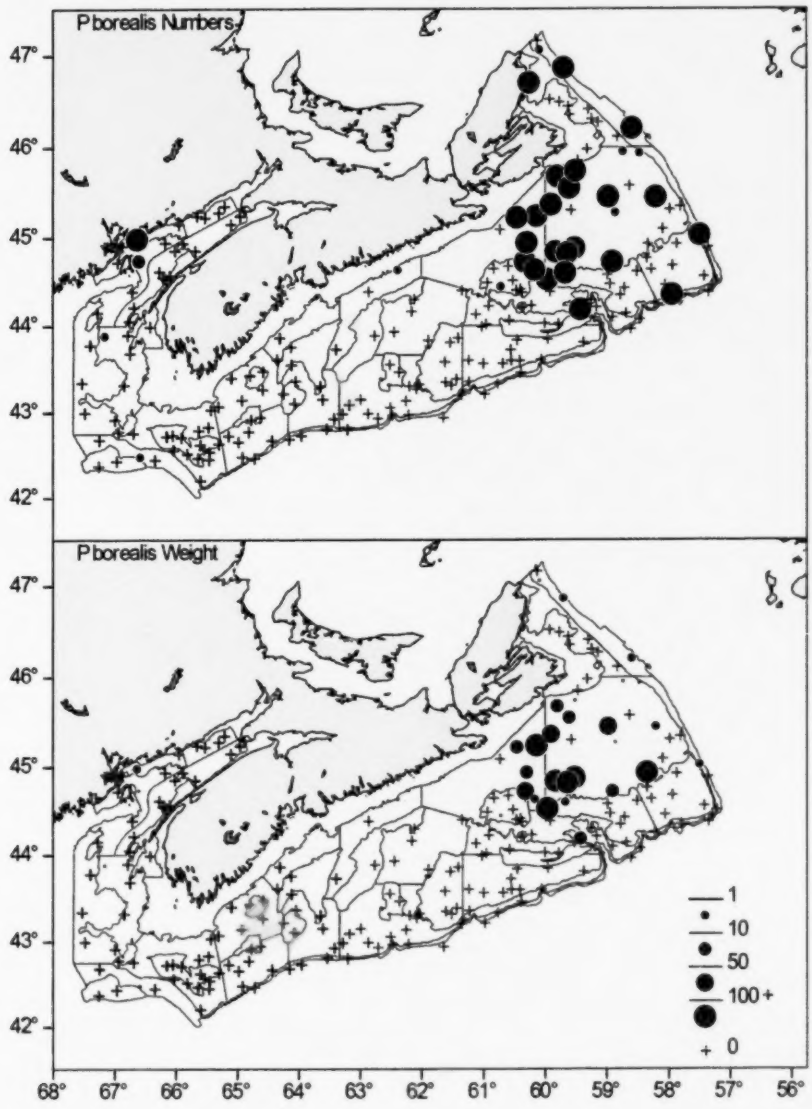

Figure 23. Distribution of *Pandalus borealis* catches during the 2006 Scotia-Fundy summer RV survey.

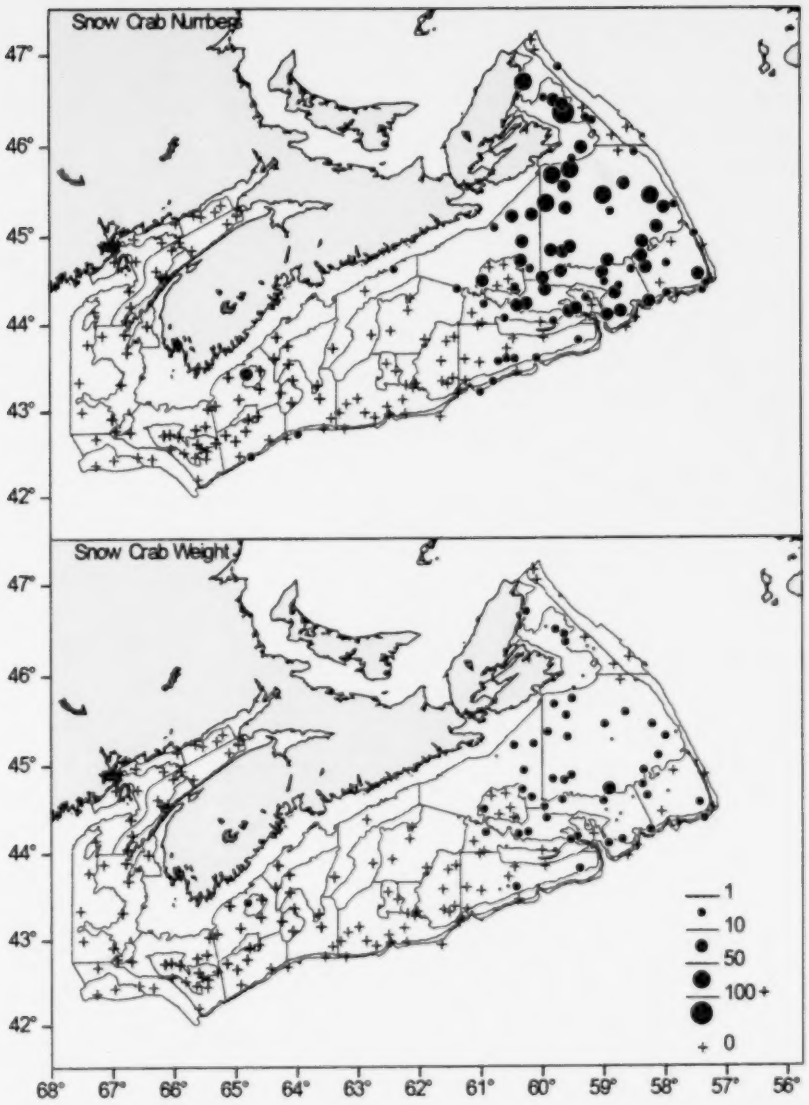

Figure 24. Distribution of snow crab catches during the 2006 Scotia-Fundy summer RV survey.

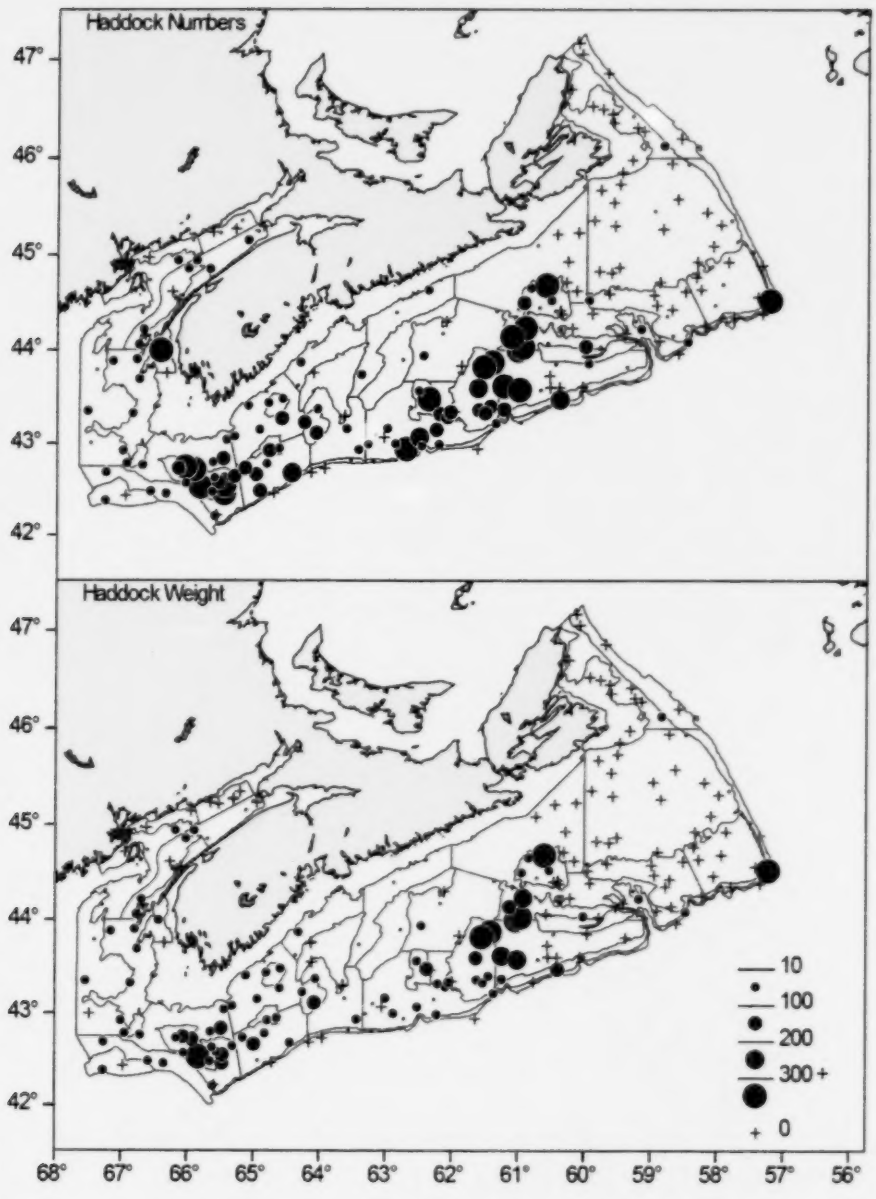

Figure 25a. Distribution of haddock catches during the 2006 Scotia-Fundy summer RV survey.

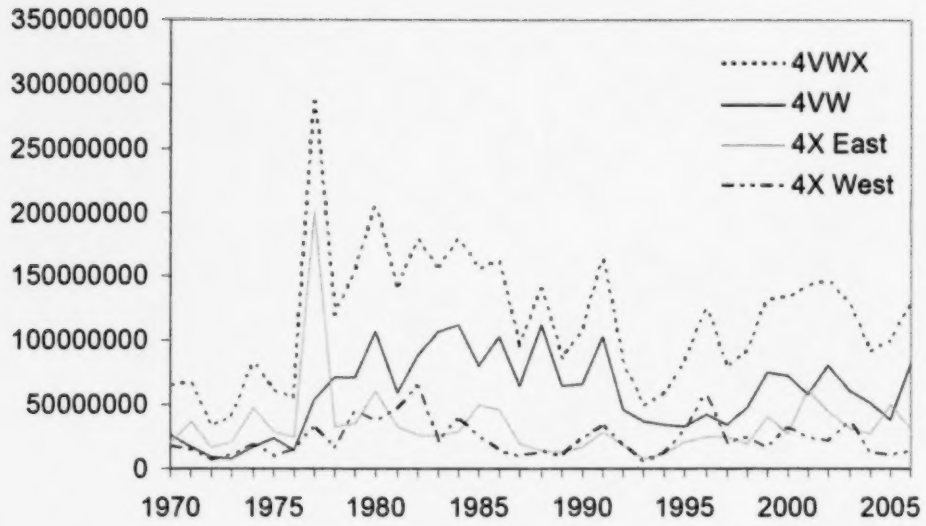

Figure 25b. Biomass estimates for haddock from the 2006 Scotia-Fundy summer RV survey.

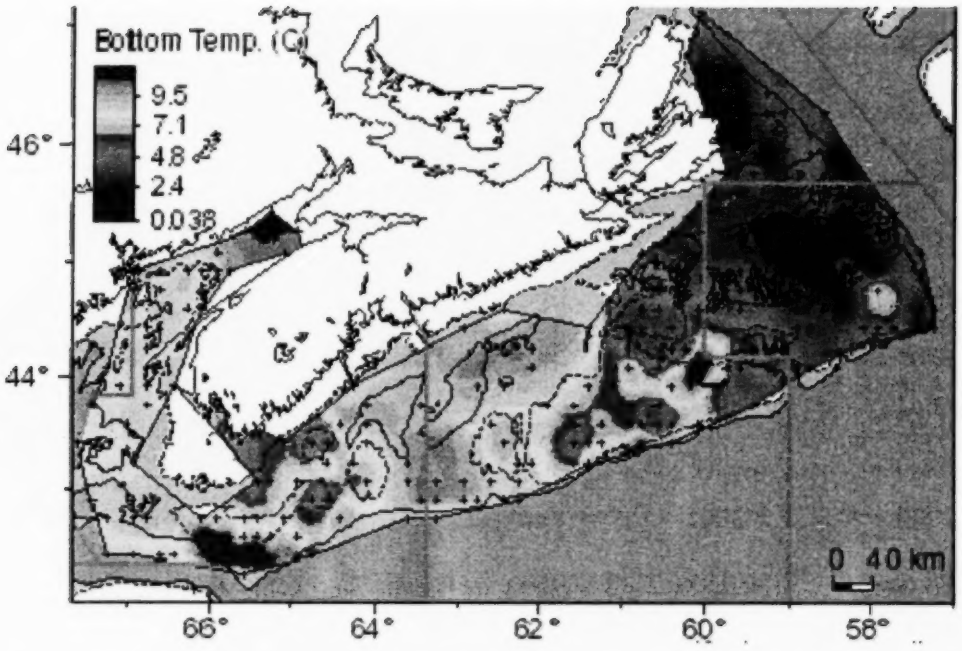

Figure 26 a. Bottom temperature distribution from the 2006 Scotia-Fundy summer RV survey.

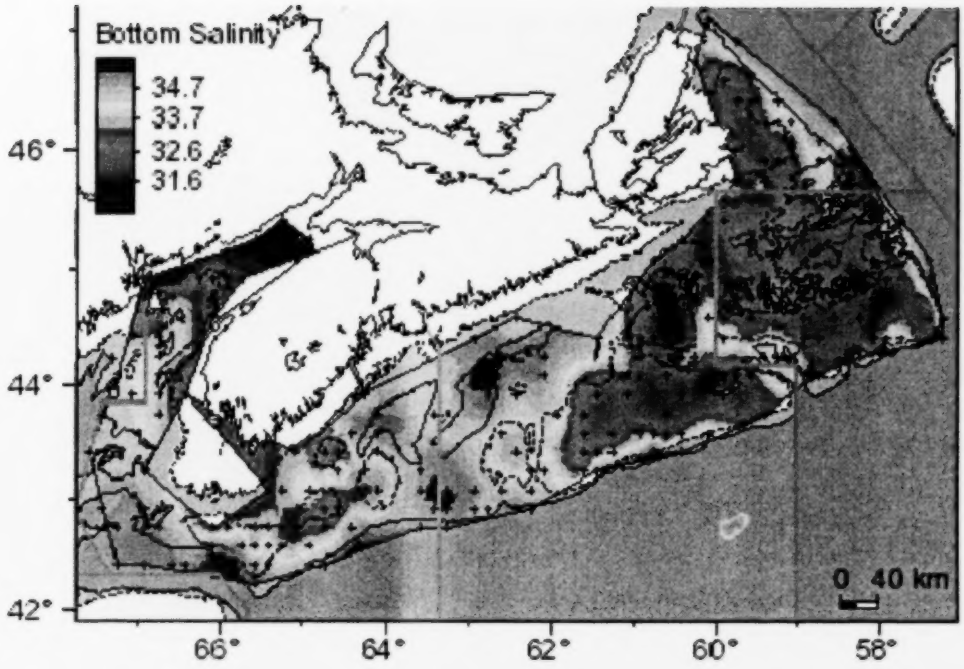

Figure 26 b. Bottom salinity distribution from the 2006 Scotia-Fundy summer RV survey.

References:

Strong, M and S. Gavaris, 1995. Bottom trawl survey reference manual. Unpublished document of DFO Scotia-Fundy Science Branch (available from authors).

Canada

Appendix I. Research Vessel Survey Programme

Department of Fisheries and Oceans Canada
Biological Sciences Branch
Maritimes Region

Bedford Institute of Oceanography
P.O. Box 1006
N.S.
B2Y 4A2
902-426-4890

Population Ecology Section
Biological StationDartmouth,
St. Andrews N.B.
E5B 2L9
506-529-8854

Vessel: CCGS ***ALFRED NEEDLER.***

Itinerary:

NED2006030	DEPARTURE:	Dartmouth, N.S.	16:00 hrs	05/07/2005
	ARRIVAL:	Dartmouth, N.S.	08:00 hrs	19/07/2005
NED2006036	DEPARTURE:	Dartmouth, N.S.	16:00hrs	19/07/2005
	ARRIVAL:	Dartmouth, N.S.	12:00hrs	1/08/2005

(possible extension to Aug. 5 if objectives not yet completed)

Objectives

1. To survey the distribution and abundance of finfish on the Scotian Shelf, Gulf of Maine and Bay of Fundy areas
2. To obtain special collections and hydrographic observation data for all tows.

Personnel

NED2006030 (Jul 5-19) Donald Clark, Chief Scientist
Watch #1 Lei Harris((i/c), TD MacDonald, Cecil Nelson, Peter Perley
Watch #2 Gilbert Donaldson(i/c), Derek Knox, Peter Hurley, Stephanie Warrington
Hydrography: Jeff Spry and Scott Wilson

NED2006036 (Jul 19-Aug 1) Bill MacEachern, Chief Scientist
Watch #1 Shelly Bond ((i/c), Linda Worth-Bezanson, Mark Showell, TD MacDonald
Watch #2 Heath Stone, Mannon Cassista, Mark Fowler, Gerry Young
Hydrography: Kevin Pauley and Jim Reid

Security Requirements: All DFO scientific personnel must have their Government of Canada ID cards with them as proof that they have been granted Enhanced Reliability security clearance.
Medical Requirements: All DFO scientific personnel must have level III health certificates.

MEDS Requirements: All DFO scientific personnel should have taken the Marine Emergency Duties course.
Cabin Assignments: Personnel will be assigned to cabins prior to the start of the survey.

Operations:

Watch #1 will work from 06:00-1200 hrs and from 18:00 hrs to 24:00 hrs on week days. Watch #2 will work from 00:00 to 06:00 hrs and from 12:00 to 18:00 hrs on week days. On weekends, overtime will be worked, according to the same schedule. Meals are to be taken before and after work shifts. Hydrographers will work 12 hour shifts, switching at noon and midnight (at their request). Hydrographic samplers will not have meals scheduled at 6:00 and 18:00, as they are on watch. They will need to fit meals around the sampling requirements, and will, on occasion, need to miss the official mealtime and find their own sustenance when time permits. The work of the vessel is not to be halted while meal breaks are taken. While the work of the Hydrographic samplers is quite distinct from the fish sampling, all decisions regarding vessel operation should continue to be dealt with by watch leaders or the Chief Scientist. Hydrographic sampling will generally take place after the set is made, although the watch leader may, on occasion, request that the hydro cast be made first for operational reasons. If there are problems in the hydrographic sampling which may result in some delay, the watch leader should be informed, and the Watch Leader or Chief Scientist should inform the Bridge and let them know how we wish to proceed with our work. This will ensure that all of us are aware of what is happening.

Following completion of the net set and hydrographic sampling, the vessel should proceed to the next station and the next set be started. If fish sampling is still underway in the lab, and an additional set is in the chute awaiting sampling, the Bridge should be requested to hold-off on the next station until the chute has been cleared and there is a place to put the next catch.

Fishing Protocol:

The survey track will be determined by the chief scientist, in consultation with the ship's officers. Standard bottom-trawl survey protocols will be followed. A 30-minute tow at a speed of 3.5 knots should be attempted at each primary station. If necessary, due to the presence of fishing gear, or untrawlable bottom, the set position may be moved (Note: new coordinates of moved stations and reasons for moving stations must be recorded by bridge staff in the Comments/Remarks column on the station lists supplied), or the station may be dropped and replaced with an alternate. Tow duration may be shortened if necesary, but must be at least 20 minutes to be considered a valid set. **Tows must not cross stratum and unit area boundaries**.

The amount of warp deployed must be determined from Carrothers' warp-to-depth ratio table for the Western IIA trawl. SCANMAR data will be recorded (logged every 15 sec.) but should not be used to adjust net performance after the net begins to tow on the bottom.

The label number assigned to the station must be recorded on the set card. Sets should be assigned experiment types according to standard coding practice. Before entering the station information in the GSE, check the label number from the Master file to see if the stratum and area given on the Station and Set Card matches the original allocation on the Master List for the survey.

Data Collection

Fish Sampling Requirements:

Basic data, total numbers and total weight caught, and length frequencies, should be collected from all successful sets according to instructions in the Groundfish Bottom Trawl Surveys Manual.

Length stratified samples are required from each set for **individual fish weights of all species** with **one per one cm stratification unless otherwise specified**. Detailed observations from stratified samples are required for selected species:

Length, sex, weight and otoliths for cod, haddock, pollock, cusk, white hake and silver hake. Dry otolith storage for all but silver hake (glycerin).

Maturities are required for silver hake only.

Observations by sex (1 per 1 cm per sex) are required for the following species:

silver hake, redfish, plaice, yellowtail, witch, winter flounder, halibut, all skates and dogfish

All 3 species of wolffish are designated species at risk. The striped atlantic wolffish (common in our survey) is listed as Special Concern and the northern (occasional) and spotted (rare) species are listed as Threatened. If at all possible discard wolfish specimens alive as soon as possible after sampling. Striped Atlantic wolffish may be retained for sampling purposes when necessary.

Invertebrate Sampling Requirements -

Invertebrates should be sampled according to *Selected Invertebrates Collected During Scotian Shelf Trawl Surveys: An Identification Guide and Sampling Protocols, 2nd Edition* (Day and Tremblay, 2000). Invertebrates should be identified to as specific a taxonomic level as possible. Most crustaceans and molluscs should be identified to the species level. The table below outlines the requirements by species (group). If broken shells are encountered only those from

live animals are to be considered for species weights. Please note that we do not sample brittle stars or basket stars as these species do not stand up well to the rigors of a bottom trawl and reliable estimates of their numbers or weights cannot be obtained. Subsampling shrimp catches in order to ascertain species composition and total numbers and weights is recommended if the catch is greater than 2 kg.

Invertebrate Species or species group	Code	Total Weight	Total Numbers	Length Frequency	Sex	Notes
Shrimp - Pandalus borealis	2211	Y	Y			
Shrimp - Pandalus montagui	2212	Y	Y			
Shrimp – Pandalid – Unsp.	2210	Y	Y			
Shrimp – Crangon – Unsp.	2416	Y	Y			
Shrimp - Unsp.	2200	Y	Y			
Crab – Jonah	2511	Y	Y	Y	Y	Use
Crab – Rock	2513	Y	Y	Y	Y	Sex
Crab – Portly Spider	2519	Y	Y	Y	Y	Code
Crab – Lesser Toad – Hyas coarctatus	2521	Y	Y	Y	Y	3
Crab - Northern Stone	2523	Y	Y	Y	Y	For
Crab – Snow	2526	Y	Y	Y	Y	Berried
Crab - Toad – Hyas araneus	2527	Y	Y	Y	Y	Females
Crab – Porcupine Stone	2528	Y	Y	Y	Y	For
Crab – Deepsea Red	2532	Y	Y	Y	Y	Crabs
Crab – Hermit – Unsp.	2559	Y	Y			And
Lobster	2550	Y	Y	Y	Y	Lobster
Squat Lobster – Munida iris	2555	Y	Y			
Squat Lobster – Munida valida	2556	Y	Y			
Sea Mouse	3212	Y	If < 25			New
Snail – Unsp. – Gastropoda o.	4200	Y	If < 25			New
Bivalve - Unsp.	4300	Y				New
Scallop – Sea	4321	Y	Y	Y		
Scallop – Icelandic	4322	Y	Y	Y		
Squid – Shortfin	4511	Y	Y	Y		
Squid – Longfin	4512	Y	Y	Y		
Squid - Unsp.	4514	Y	Y			
Octopus - Unsp.	4521	Y	Y			
Squid – Bobtail – Unsp.	4536	Y	Y			
Starfish - Unsp.	6100	Y	If < 25			
Green Urchin – Stronglocentrotus droebachiensis	6411	Y	If < 25			
Purple Urchin – Arbacia punctulata	6421	Y	If < 25			
Sand Dollar – Echinarachnius parma	6511	Y	If < 25			
Sea Cucumber - Unsp.	6600	Y	If < 25			

All fish caught must be identified to the species level. If this is not possible at sea, they should be preserved and returned to the Atlantic Reference Centre for positive identification. This should be noted in the comments section as "ARC specimen". A tally sheet of specimens colected for the ARC should be maintained in the Dry lab, and at the end of the survey a copy should be made to be delivered to the ARC with the frozen specimens, and two copies returned with the set cards – one for the Cruise records, and one for the program manager (D. Clark).

Whenever possible, the total catch should be processed. Sub-sampling may occasionally be necessary for large catches, following established protocols.

Trial Sampling

Herring sampling at sea and stomach sampling by the fish lab staff will be conducted. We will be determining the feasability of including sampling of this nature as part of the standard protocol. All efforts should be made to complete this sampling. If it is too time consuming and is jeopardizing our goal of completing all primary stations, the Chief Scientist may have to curtail this sampling. The Chief Scientist should be informed how these sampling requirements are impacting on progress.

Herring Sampling:
For **herring** we would like to change the processing at-sea this year so that most of the data collection is now done on the vessel and recorded in the GSE. We would like to have stratified samples (2 fish per cm group) sampled from ALL sets where **herring** are caught. These can be selected for detail as they are measured as part of your standard protocol. The protocol would be:

- Measure herring as part of standard protocol using groundfish offset board and measured as fork length
- Herring are identified by GSE for detail (2 fish per cm), take weight, sex, maturity, otolith number assigned, extract otolith put in otolith envelope
- Since we need total length (tip of nose to tip of tail extended) in mm a second measurement is required using a herring board (no offset with scale in mm). This measurement should be recorded in the comments field in the form Tmmm where T is for total and mmm is the length (i.e. T281)

Special Sampling Requirements (subject to additions/deletions)

Additional sampling has been requested for a variety of species. These should be completed as time permits.

1. Dogfish - collect live fish and return to BIO. (Warren Joyce)
2. Dogfish - additional biological sampling will include condition samples (dressed weights, depressed fork length), ageing materials (second dorsal

spine), maturity stage data, fecundity data, and for embryos: fork lengths, sex and yolk sac lengths. (Warren Joyce)

3. Pollock gill tissue for genetic analyses and total-fork length comparison (John Neilson)
4. Winter Skate fin clips for genetic analyses (Lorraine Hamilton)
5. Bar Code of life – all species
6. round cod <30 cm. from Western-Sable Banks and 4Vn(Carl MacDonald)
7. Skate Purse Identification – weigh and count and enter in GSE.
8. Coral (Cynthia Bourbonnais)

Hydrographic Observations:

At all stations successfully fished by the *Alfred Needler*, profiles of temperature, salinity, oxygen, fluorescence and irradiance (PAR extinction) will be obtained with a SBE-25 CTD on a rosette deployed by the *Teleost*. Niskin bottles attached to the CTD-Rosette will collect water samples from the bottom, intermediate depths, and from near surface. VEMCO depth/temperature MINILOGGERS will also be attached to the trawls during each set to monitor the temperature of the water strained by the nets.

In addition to the sampling described above, one vertical zooplankton net tow from bottom to surface (200 microns with flow meter if possible) will be conducted for the Atlantic Zonal Monitoring Program (AZMP), at stations identified on the Station Master List.

Trawl mensuration:
Minilog sensors will be deployed on the trawl. Scanmar sensors will be used to document trawl characteristics.

Vessel tracks from GPS and Scanmar data:
The track of the vessel during towing should be provided by the bridge personnel to the chief scientist. Scanmar data should be provided to the chief scientist.

Additional Documentation:

Additional documentation relevant to special sampling collections will be distributed and discussed during the pre-cruise briefing.

General Sampling Notes

- Do not discard anything while the net is in the water
- The electronic balances must be calibrated every day (Record calibrations on the daily checklist posted in the fish lab for this purpose.)
- On the Catch Form, total weights for each species must be entered in kilograms
- Whenever the GSE system issues a length-weight warning, both the length and weight should be verified. This should be recorded in the 'comments' field (LW verified).

- When measuring fish with the 0.5 cm offset measuring boards, record the 'LENGTH THAT YOU SEE' (i.e., record the length that appears after the tip/fork of the fish tail)
- All fish with forked tails should be measured for fork length.
- Except for unusually large catches (e.g., > 40 baskets), all catches of dogfish must be weighed and sampled in the fish lab. Basket count is an acceptable estimate of weight for unusually large catches.
- Be alert for tagged fish when sorting catches and sampling. If tagged fish are recaptured, measure their length to the nearest cm and freeze with a label indicating the cruise #, date, set # and length in cm (Do no further sampling of the fish, leave the tag on and make a note in the remarks column of the GSE). Inform the chief scientist of the need to inform the agency noted on the tag.
- In the event of unsuccessful sets and time permitting, the watch leader could direct the deck crew to empty the catch into the ship's hopper for processing by scientific staff to assist with completing special sample requests.
- All fish should be removed from the trawls at the end of every set to prevent 'carry-overs' from previous tows.

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Population Ecology Section
Ecosystem Surveys

Tuesday, 01 May 2007